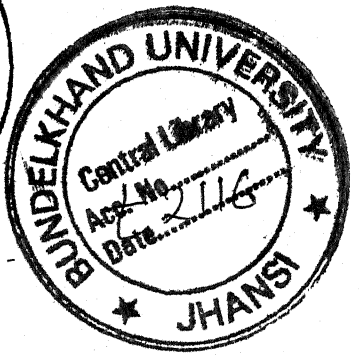
"LIMNOLOGICAL STUDIES OF VIJAY SAGAR LAKE IN MAHOBA DISTRICT"

THESIS
Submitted for the Degree of Doctor of Philosophy
in Zoology

Bundelkhand University,
Jhansi (INDIA)





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CERTIFICATE

It is hereby certified that the thesis entitled **"Limnological studies of Vijay sagar lake in Mahoba District"** is being submitted to the Bundelkhand University, Jhansi (U.P.) by Mr. Ashok Kumar Singh under my guidance and supervision for the award of the degree Doctor of Philosophy in Zoology. The candidate has put in an attendance of more than 200 days with me. To the best of my knowledge and belief the thesis, embodies the work of the candidate himself. It fulfills all the requirement of the ordinance of the university relating to the Ph.D. degree.

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DECLARATION

I hereby declare that the thesis entitled **"Limnological studies of Vijay sagar lake in Mahoba District"** is completed by me under the guidence and supervision of DR. K.V. Singh Ex. Reader and Head, Deptt. of Zoology Pt. J.N.P.G. College, Banda. This is submitted to the Bundelkhand University, Jhansi (U.P.) in fulfilment of the requirment for the award of the degree of Ph.D.. Thesis or a part it has not been previously submitted for the award of any degree. It is my original work.

As regards literature I consulted libraries of Sagar University, Lucknow University, C.S.A. University, Kanpur and Allahabad University for the research paper and Journals. I took the participation in U.G.C. National seminar in which I presented my research paper "Impact of animal wastes on environment of Banda".

17 Dec. 2005

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INTRODUCTION

INTRODUCTION

Water is the most essential factor for the existance of living organisms. It is certainly a part of life in itself. Protoplasm of the living cells contains about 80% of water which participates either directly or indirectly in all metabolic activities. The amount of water on the earth is about 1.4×10^{9} Km^{3} which covers about 70% of earth's surface which an average depth about 300 meters in the form of oceanic brine. Out of the total amount of water 96.42% is found in oceans, 1.78% is in the form of ice sheets and rest is as fresh water.

The total amount of the fresh water on the earth is estimated to be 29×10^{6} Km^{3} which is about 0.2% of the global water. Out of this about 10% is lying in Baikal lake in U.S.S.R. and about 20% in five laurential lakes of Canada and U.S.A. & rest 70% is in the forms of rivers, reservoirs, ponds, tanks and lakes etc. Thus there is only a small and definite quantity of fresh water to meet all the direct and indirect requirments of the infrastructure associated without life and industrial processes.

Water has many special properties which make it suitable for the life. It is called an universal solvent because it decomposes more substances than any other liquid without any chemical change. Hence being an inert compound, it also transports various essential substances without any change in living cells. But the water quality of lakes, ponds and tanks is deteriorating rapidly mainly due to rapid increase in human settlements nearer to these places, improper sanitation and run off pestiscides and various fertilizers from cultiviable land. In order to save the water quality status of fresh water bodies there is a need of data based study at present.

India is rich in inland waters. These water bodies are used to culture the aquatic animals mainly fishes for human consumption. If we manage these water bodies properly then considerable increase in producation might be taken Limnologists did primary production studies to resolve the organic productivity of aquatic system.

In India there are various publications, In this regard. Most of these studies are related with ponds and reservoirs while to some extent the rivers and lakes have been left unexploited. Though comprehensive work on limnology has been done in western countries. In India more than 60,000 water bodies are found in the from of ponds lakes etc. But a large number of these water bodies have not yet been explored.

The increasing use of water for drinking and domestic consumption, fisheries, power generation, irrigation, navigation and recreation has necessitated careful management of our reservoirs, ponds, lakes, rivers etc. For this the practical accurate information in respect of water qualities required.

The lentic limnology is different from lotic in many respects. The former is rising whereas the lotic is static in numbers. There are more manmade lakes. Ponds and tanks in the tropics than natural lakes. (Fernunds 1980). So informations on these important aquatic ecosystem are urgently required for their mangement, Many reservoirs will never approach the status of natural lakes (Marzolf. 1984) whereas these are more like rivers than lakes (Taub 1984).

Reservoirs the manmade ecosystem have tremendous potential for increasing inland fish prodcution if managed through sound ecological management principles. Phytoplankton primary production coupled with

knowledge of sediment and water qualities could be utilized for evaluating productivity of such water bodies (Goldman, 1960 Melock 1976 Oglesby 1977). This aspect of primary production and limnochemistry of tropical indian reservoires have been well documented (Sreenivason, 1970, Unni and Patil 1995 and Ramkrishnih and Das 1998). However wide variations in morphoedaphic features catchment ecology and anthropogenic activities make these reservoirs vulnerable to be studied individually which formulate sustainable management norms for augmenting fish production.

The resevoirs, lakes, ponds and tanks are the main fresh water sources in our country which play major role as potential source of fishries, besides they are also the source of irrigation with integrated approach. The lakes, ponds & tanks are untapped source of rural wealth utilization which also generate higher, income and employment by rising fish culture.

The great diversity of lakes is also represented in ponds since not only are the conditions of origin, distribution and general status similer, but also ponds are often themselves the evolutionary successors of previously existing lakes. In much respect. Thus limnological knowledge of lakes is much more advanced than that of ponds.

The rivers are also the good resource for higher fish production. To achieve high yield per unit area from aquatic ecosystem, it is necessary to understand the relationship of physical, chemical and biological features .

It is well established fact that domestic sewage and industrial effluents into natural water result in changes of water quality and cultural eutrophication (shaw et, al, 1991) . The other important sources of water pollution include

mass bathing, rural waste matters, agricultural run- off and solid waste disposal sections (Mishra and Saksena 1992).

Fishes are very useful indices of the state of purity of water. The fishes are used as the substitute of the food in the from of proteinous diet. Hence, it- fulfills the scarcity of the food, for the high production of fishes. The different lentic water bodies are scientifically managed so that their physico chemical characteristics of the water and soil conditions might be made suitable for the high fish productivity.

The plankton density also affects the fish production. The population of plankton fluctuations are found. As zooplankton show vertically, diurnal and seasonal whereas phytoplankton have mainly seasonal fluctuations. These are chiefly due to photoperiod and temperature of the water. Besides, various seasons and factors have impact on the physico- chemical nature of the water which influenced the biota of the water body. Hence such factors are considerad in the study of the lakes.

The soil also plays an important role in determining the fertility of fish ponds and lakes . The bottom soil becomes blackish and muddy due to suspension of falling of trees leaves, excreta of the birds, inorganic and organic matierials etc. It is in the form of colloidal complex which is due to the storage of nutrient materials such as nitrates, phosphates, potassium and calcium which changes the colour of the soil. Inspite of reasonably high nutrient concentration at soil phase, it was not adequately reflected in water phase owing to rapid and instant uptake by the macrophytic stands in the lakes (Palui and Jha, 2003). Banerjee (1967) is also of the opinion that important chamical factors of the pond soil are- p^H, total nitrogen, total phosphorus,

organic carbon c/n riatio, available phosphorus, potassium and exchangeable-calcium are responsible for the productivity of the pond ecosystem.

Soil and water are two basic natural resources whose continuance and management or obtaining importance for increasing aquaculture and intensifying productivity about 70% water goes waste. If these run off water might be properly storred by digging additional water bodies and bundhies, which could be used properly for aquaculture that will increase much more production of the fishes.

All lakes irrespective of their size on the basis of thermal character are of three types namely polor temperate and tropical according to Forel (1892). Further on the basis aquatic weeds infestation and phytoplankton lakes are of three types are found i.e. oligotrophic, eutrophic and Dystrophic (Welch 1935) Having in view the above facts the Vijay sagar lake is tropical and an eutrophic because it is located in tropical region and rich in weeds.

Uttar Pradesh, being a land locked state, possess only fresh water resources with exception of negligible salty waters present in western region. Total water area available in state is estimated to be about 1.65 million hectares. Out of which 0.7 million hectores in confined area. In confined waters about 0.162, .150 and .133 million hectares is remarkeble as rural ponds, reservoirs and lakes respectively (Anon, 1999). In open waters only capture fishery is possible while confined waters can be used for capture and culture fishery. Data on sector wise utilization and productivity is scares. However ponds, lakes and reservoirs get relatively more attention with the result of higher productivity which is 2350 Kg./ha/yr in ponds and 119 Kg./ha/yr reservoirs.

Bundelkhand region of uttar pradesh lies in central plateau region. It is predominantly draught prone area and need for stored water has resulted in the construction of a large number of water bodies. Fisheries in this region occupies unique characteristics due to varied geo- physical conditions, located between 23°8'- 26°30' N latitude and 78°11'- 81° 30' E longitude with an area of 19264 square kilometer and 879 mm averge rainfall. This area has tropical monsoon climate receiving 95 percent annual rainfall during monsoon period only.In Bundelkhand region of uttar pradesh very little work has been done on fresh water whereas in Mahoba district on work on ponds and lakes has been reported so for though there are so many reservoirs, lakes and ponds viz.- Keerat sagar, Madan sagar, Kalayan sagar, Belatal, Salarpur and Vijay sagar etc.

Vijay sagar lake is tropical and an eutrophic has been selected for the limnological study as regards to its physiography climatic conditions physico chemical and biological characteristics and soil analysis also and their impact on the fish production. Regarding its physiography it is located about six kilometer from Mahoba city on Banda Mahoba road and located in south west of the Uttar pradesh and comes in mahoba district at Chitrakoot Dham Banda commisonary.

Vijay sagar lake is quite deep but it's peripheral zone becomes shallow due to soil erosion. It acquires area of about 450 acres in monsoon period. Its latitude 25°6'- 26°7' N; longitude 67°17'- 80°5' E; and surrouded by hills on northern and southern sides which comes under Vindhya range, where as the eastern side has embankment there is plant nursary inspection house and water supplied to irrigation purpose for the military camps also.

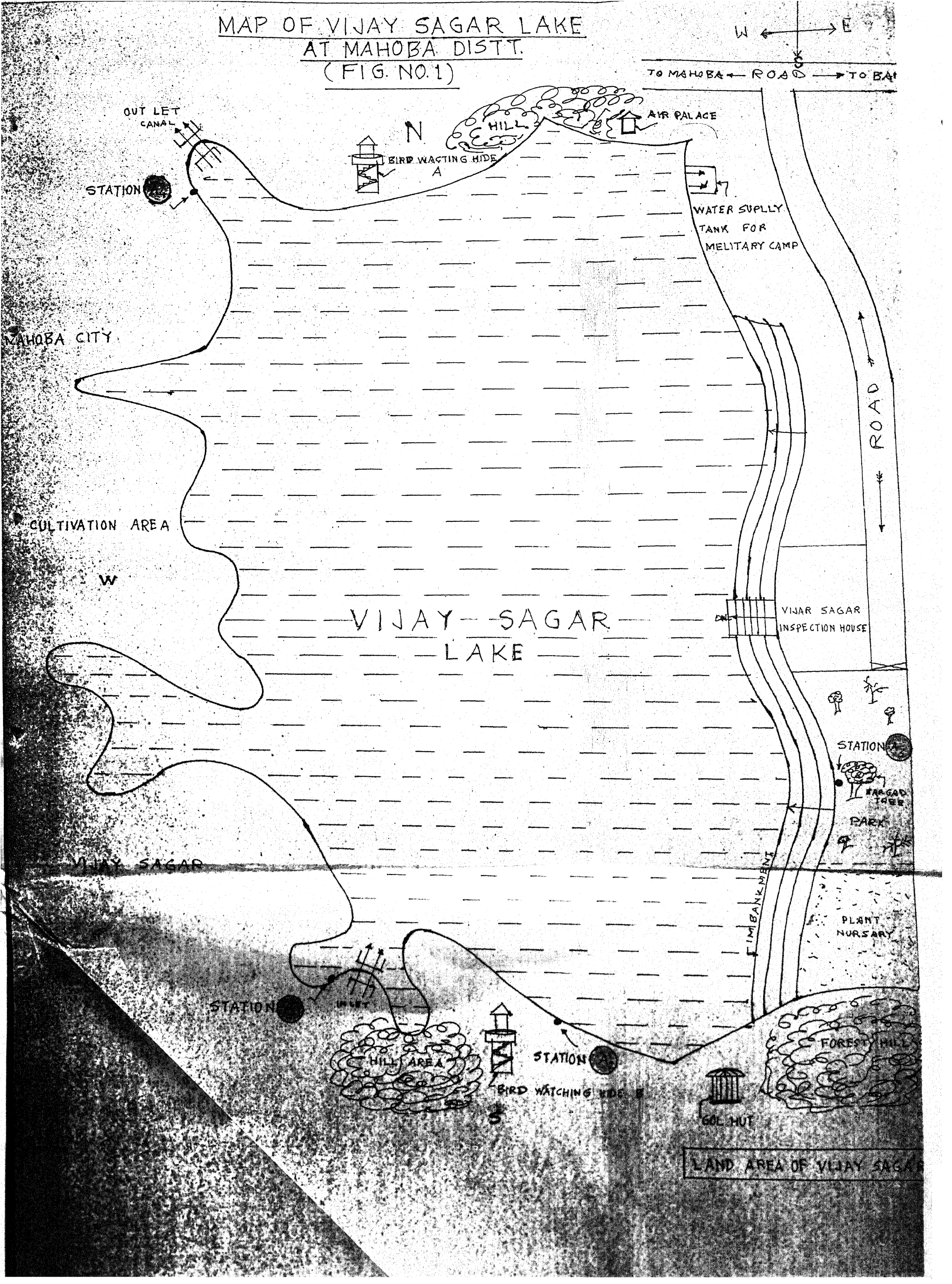
On this embankment trees are found which are- Ficus bengalensis, Ficus religiosa, Tamarindus indica and some shrubs and herbs like cynodon dactylon Nerium odorum etc. On the eastern side of lake is dense forest in which many wild animals and medecinal plants Viz- animal- Lepord, Fox, Jackal, Deer, Poisinous snakes , Scorpion, Honey bees etc. and medecinal plants- Banyan, Peepal, Neem& valuable shrubs Holy basil and Basil etc.

This lake is perennial has sufficient water throughout the year. The lake is slightly marshy and is provided with abundant weeds on its margins. The water supply for this lake is by a canal which comes from salarpur reservoir. This canal is inlet of the lake. There is an outlet which has two canals viz- chandui and sahdasrapura branch for irrigation. It is also bird's sanctuary because a numbers of migratory birds migrate from temperate regions during winter season and it is also a place of tourism. The lake is being polluted to some extent by human and cattle activities etc.

Having in view it's physiography along with other considrable factors and directions four sampling stations were selected. Monthly water samples, plankton collection fishes of the food value were collected and their physical shortly chemical, soil samples analysis and biological studeis were done for the period two years from (Dec. 2001- Nov.2003)

The main aim of the study is to suggest various scientific measures to manage properly this large water body for the maximum production of the fishes, which are the protenious food thus might be helpful solve the food problem and simultaneous good revenue besides, maintain if for the suitability of bird's habitat specially for the migratory bird's that this lake might be an ideal one as regards tourist place also.

MAP OF VIJAY SAGAR LAKE AT MAHOBA DISTT.
(FIG. NO. 1)



REVIEW OF LITERATURE

REVIEW OF LITERATURE

In India about 3.0 million hectare of land is full of aquatic system and lot of work has been done from different aspects. However, few workers have studied the aquatic system of lakes, ponds, reservoirs and rivers in relation to the aquaculture. Moreover in other countries the limonlogical studies have attracted a large number of workers :-

The earlier studies of marine life had been started during the time of Aristotle (384-332 B-C). However no significant contribution of a strictly limonlogical nature appeared till early nineteenth century. During later half of nineteenth century and early twenteenth century physico-chemical and biological work in the field of lake, pond and reservoir investigations had been directed. Secchi (1856) devised Secchi disc to note light penetration in water. Winkler (1887) proposed the technique to measure the Dissolved Oxygen content of water. Hanson (1887) proposed the term plankton to include all the minute animals, plants, and debris which were found suspended in natural waters. Some of the tropical countries the earlier notable contributions for the limnogical knowledge of lakes, ponds, and reservoirs were of Birge and Juday (1912). Juday (1915-1916) who investigated in detail the Finger lakes of Newyork and certain lakes in central America respectively. Allen (1920) made observation on the quantitative and statistical study of the plankton of San joaquin river and its tributeres in and near stockton, while Griffith (1923) .Observed the phytoplankton of fresh water in relation to occurrence and composition. Atkin and Harris (1924) studied the seasonal changes in the water and heleoplankton of fresh water pond. Gardner and Gran (1927) introduced the light and dark bottle technique for the measurment of phytoplankton productivity of water. Carpenter (1928) gave an account of life

in inland waters Graham (1929) investigated the temperature and pH measurment in the Victoria Nyanza. Jankin (1929) gave physical and chemical conditions of five lakes in kenya. Butcher et.al. (1930) studied variations in the composition of river waters. Pearsall (1930) studied the composition of phytoplankton in relation to dissolved substatances. Wiebe (1930) investigated plankton production in fish ponds. Worthington (1930) investigated temperature hydrogen-ion concentration and alkalinity in shallow gulf and open water in victoria and Albert Nyanzas.

Atkin (1932-33) studied the chemistry of sea water in relation to the productvity of the sea. welch (1935) emphasized on the measurment of water temperature and calculation of heat budgets. Juday et. al. (1935) studied the carbon-dioxide and hydrogen-ion concentration of the lake waters of North eastern Wisconsin. Sewell (1935) studied the tropical and subtropical waters in certain areas.Ohal (1938) determined pH and alkalinity and correlated them with control of liming of ponds. Smith and swingle (1938) reported relation ship between plankton and fish production in ponds. Presscott (1939) observied some relationship of phytoplankton to limnology, aquatic biology and objectionable algae. Chandler (1940) made observation on the plankton and certain physico-chemical parameters on light penetration and its relation to turbidity and in the relationship of phytoplankton to the limnological and climatic factors of western lake of the Bass. Islands, while Hutchinson (1941) studied the mechanism of intermediary metabolism of stratified lakes in connecticut. Hutchinson (1947) observed the direct relation of the phosphorus cycle in a small lake.Patrick (1948) studied factors affecting the distribution of diatoms. Tyron (1952) did the analysis of the summer plankton productivity in Pymaturing lake in Pennsylvenia. Lauff (1953) studied the phytoplankton in relation to the water chemistry of Rogers lake. Mc combie (1953) reported factors influencing

the frowth of phytoplankton. Matsudaira and Kato (1953) made observations of the impurities in rain water in Osaka and Kobe cities. Cushing (1954) observed some problems in the production of oceanic plankton. Pennak (1955) did a comparative limnological study of eight lakes of Colorado mountain. Griffith (1955) did the analysis of plankton yields in relation to certain physical and chemical factors of lake Michigan. Byars (1960) investigated the physico-chemical factors and plankton of fresh water pond in new zealand, while Hozelwood and parker (1961) worked out the population dynamics of certain fresh water zooplankton. Phillips (1964)studied the ecological role of phosphous in waters with spceial reference to microorganism. The investigation on the fluctuations of plankton in a fish pond in Assam with referance to water conditions was done by Baruah (1964). Prochoskeva (1965) observed seasonal changes of nitrogen compounds in two reservoirs.

Lund (1965) observed the ecology and seasonal distribution of plankton in different fresh water bodies. A significant relationship between wind spread and dissolved oxygen in Anturctic lakes was established by Baker (1967). A limnological studies of lakes of the Venezuela High Andes was conducted by Gressner and Hammer (1967). Anderson and Armstrong (1967) studied the Zooplankton and phytoplankton relationship of Davils lake of north Dakota. Weir (1968) said that the alkalinity and pH of ponds in central Africa, varies with the physical nature of ponds. Besides all type of ponds showed a cyclic seasonal variation in pH and alkalinity.

Watanabe (1968) made observations and daily changes of temperature and dissolved oxeygen in a pond in the Suburbs of Tokyo. Populations dyanamics studies of pond zooplankton were made by Armitage and Smith (1968).

Patals and Patalas (1969) noticed that plankton abundance fluctuate with the variation of electrolyte content of the all was observed by Lind (1969). Nicola and Borgeson (1970) studied three lakes to determine relationship between the chemical and physical characteristies, primary production and zooplankton standing crop.

Distribution of Zooplankton Complex due to diurnal vertical migration related to the horizontal movement of water layers was noted by Chapman (1970). Sorgeloos (1970) made an ecological study of two small ponds in the environs of wevelgem (west Flanders) and found dthat the 'Park' pond was low in oxygen which was probably beacuse of the low phytoplankton density and cladocera and copepoda dominated in the zooplankton. A study of a series of lakes in south eastern France showed that their water are homoiohalines, slightly acidic and well oxygenated. Vekhov (1973) while observing zooplankton of lakes of the Bol Schezemcls kayar tundra. found that small lakes are characterized by an almost complete absence of pelagic rotifers except Conochilus unicernis.

Dagget et.al. (1974) carried out the seasonal quantitative study of littoral cladocera and copepods in Bay pond and acid marsh in new foundland. Nesterova and Polischuk (1975) made in investigation on the relation between total quantity of phyto and zooplankton in the surface layer and found that there was no relationship between the total quantity of phyto and zooplankton. Hydrochemical characteristic of Oral river, a left bank tributary of Dineper river in the U.S.S.R were investigated by Varenko (1975) and he reported that the Comparatively high value of dissolved oxygen is conditioned by phytoplankton development. The biolgical aspects of the river Buriganga near Dacca, Bangladesh were studied by Islam and Haroon (1975).

The seasonal cycles of abundance of the phytoplankton and zooplankton in lake Otatoa newzealand were observed by Green (1976). Ayyappan et. al. (1980) studied limnologye of Ramasamudra tank while Singh and Desai (1981) studied limnological observation on Rihand reservoir. Singh et. al. (1982) described seasonal changes in plankton population of some freshwater ponds at Patna. Bihar (India). Ramakrishnaih and Sarkar (1982) studied plankton productivity in relation to certain hydrological factors in Konar reservoir (Bihar).Singh (1983) studied hydrobiological observation on Shahjahan garden pond at Agra.Singh (1985) studied limnology and productivity of mcpherson lake Allahabad. Dwivedi et. al. (1986) studied limnology and productivity of Kulgarhi reservoir (M.P.) Planktonic succession in a tropical pond near Mangalore was studied by Pushpendra (1987). Singh and Saha (1987) Carried out the primary productinity studies with reference to physico-chemical parameters in composite fish culture pond.Singh (1987) studied limnological observations on Circuite house pond at Agra. Anitha kumari et. al. (1989) studied limnology of Temple tank in Thiruvanthpuram (Kerla).

Seasonality in river phytoplankton was studied by Peterson and Stevenson (1989). Distinct shifts in algal dominance were identified between spring, late summer and tran sitional period in systems. Abundance of Anacystis, Oscillatoria, Scenedesmus and Melosira were strongly positively correlated with temperature while chlamydomonas and Navicula were inversly related to temperature Haque et. al. (1990) studied composition and seasonal abundance of phytoplankton in a tropical fresh water pond at Aligarh. They recorded five groups of phytoplankton and order of abundance was myxo, chloro, Bacillario, Eugleno and Desmidiaceae. Seasonal fluctuation in total phytoplankton showed a diacmic type of distribution. An inverse relationship was found to be present between phytoplankton numbers and transparency,

phosphate, phosphorus and pH of the water, while a positive relationship was recorded between phytoplankton and zooplankton. Studies were conducted on the zooplankton density of river Ganga between Kalakankar and Phaphamau Allahabad by Srivastava et. al. (1990). They observed that the zooplankton density was maximum during summer and minimum during the rainy season. Khan (1990) described the significance of limnology in the management of manmade lakes.

Limnalogy of a tropical pond with reference to fisheries has been investigated by Singh (1990). He found that plankton population showed bimodel pattern of fluctuation with one peak in winter and other in summer. Most of planktonic organism showed seasonal variation in density and period of occurrence. Singh and Ali (1991) investigated physico- chemical factors and phytoplankton of pawapuri pond and observed that pH, Dissolved oxyegen, Alkalinity, chlorides and phosphate depicted erratic seasonal, seasonal fluctuations imparting profound impact on the phytoplankton. Patralekh (1991) studied phytoplankton periodicity in perennial pond of Bhagalpur, India and observed that phytoplankton population exhibited marked fluctution in different seasons.

It's maximum population was recorded in march and minimum was found in August. Impact of fishing management in Cladoceran population was studied by prazakava (1991). During the two years cycle of fishery management in the first year of cyele biomass of large Cladocerans prevailed. The species Dapnia guliota was present in both years. It was more numerus in the second year. Chiv (1991) studied diurnal depth change of iethyoplankton in the Kuroshio edge exchange front. Densities of icthyoplankton was low in day

time and high at night. In day time surface water was dominated by Scatophages argus and Apogen lineate and the mid water was Benthosema pterotcum.

Noustaka et. al. (1992) studied phytoplankton and physico-chemdical features of Tavrops reservoir Greece. Seasonal sequence of biomass showed three annual peaks. Diatoms , cryptophytes, chrysophyte and dinoflagellates were the major censtituents of reservoir phytoplankton. Adhikary and Sahu (1992) investigated distribution and seasonal abundance of algal forms in Chilka lake east coast of India. These authors in (1993) investigated phytoplankton seasonality and their relationship with physico-cchemical properties in a hyper eutrophic central Indian lake. Bose & Gorai (1993) observed seasonal fluctuation of plankton in relation to physico-chemical parameters of a freshwater tanks of Dhanbad India . Inee's 'O' Farrell (1993) studied the phytoplankton ecology community structure dynamics and limnology of Salado river (Buneos Aeres Argentina). Ecological studies on the Kerkini reservoir (Greece) was studied by Kamarianos et. al. (1993) and observed that cyanophyceae, chlorophyceae, dinophyceae deatomceae. chrysophyceae in considerable seasonal variation in their abundance diversity and number comparised the phytoplankton population. The abundance of Rotifer and the presence of various copepode throughout the year were also characteristic. Jacqueline et. al. (1994) studied comparative limnology species diversity and biomass relationship of zooplankton and phytoplankton in five fresh water lakes in Kenya. Forell and Izaquirre (1994) described the seasonality, distribution and structure of the phytoplankton community of the Uruguay lower basin (Argentina) they stated that temperature showed up as one of the most important factors in the regulation of quantitative and qualitative community seasonal changes.

Seasonal trends in densities of various zooplankton were investigated by Dumont et. al. (1994) from density graphs. They stated that period of peak density was associated with high nutrients fluxes. They also described the comparative limnology, species diversity and biomass relationship of zooplankton and phytoplankton in five fresh water lakes in Kenya.

Kebede and Belay (1994) described the species composition and phytoplankton biomass in a tropical Affrican lake (Lake Awassu Ethiopia). Kaushile and Sharma (1994) studied the physico-chemical characteristics and zooplankton population of a perennial tank, Matsya Sarovar, Gwalior. The seasonal variation of zooplankton showed a bimodal pattern in this tank. The first peak appeared in June and the second peak in february. The rotifer formed majority over the other zooplanktonic groups.

Singh (1995) describe the Physico- chemical and biological factors of the river Ganga at Kanpur. He stated that these factors are direct effected the aquatic biota of river Ganga.

Bais and Agrawal (1995) made the comparative study of zooplanktonic spectrum in the sagar lake and Military engineering lake. They identified that the protozoa, Rotifera Cladocera, Ostracoda and copepoda were the main groups in both the lakes. They also found that the main limiting factor which hampered the density of zooplankton population in the military engineering lake was a very low population of phytoplankton. Mwachiro et. al. (1997) investigated the heavy metal status of the reservoir Barinear Udaipur (Rajasthan) and the accumulation of the metals in fish organs, and found that the concentration of heavy metals in the water of the reservoir and fish organs in high due to mining activity of udaipur basin. Khan. et. al. (1998) stated that

seasonal variation in the abundance and composition of phytoplankton in river Ganga at Narora, (U.P.) Limnologial parameters of a Temple pond in Kerala were investigated by Chandrasekhar. and Jafar (1998). Phytoplankton primary production and fish production potential of Nelliguodha reservoir (Banglore, South India) were studied by Krishna and Shakuntala (1999).

Ramakrishnaih, and Rao, (2000) reported the ecology and fish potential of selected reservoirs of Karnataka. Azizul, et. al. (2001) reported limnological parameters of fish ponds in Rajshai Bangladesh. Bharathi, et. al. (2002) investigated on hydrobiological features of Kolavoi lake in chingleput district. Kumar et . al. (2002) described the performance of Indian fisheries sector and pillai, et. al. (2003) reported productivity trends in two flood plain wetlands of Bihar.

Iqbal, (2004) studied the hydrobiological studies on river Nakatia at Bareilly. Dubey and upadhyay (2004) investigated ecological restoration and sustainable development problems and perspective.

METHODOLOGY

METHODOLOGY

Limnological studies of Vijay sagar lake was done having in consideration various abiotic and biotic factors for which the parameters were taken viz-water movement, water temperature, depth, colour, turbidity, p^H,total alkalinity(Carbonate and bicarbonate), CO_2, D.O. Chloride, ammonical nitrogen, phosphate, aquatic weeds, plankton and economically important fishes and chemical conditions of soil.

The above parameters were examined physically and by chemical analysis during the study period of two years (Dec. 2001 to Nov. 2003) .Besides the physiography and directions of the lake was also studied. on its basis four sampling stations which are having different conditiions were selected to study the characteristics of water and soil to fullfil the requisities of limnological studies of Vijay sagar lake.

Station A_1 :-

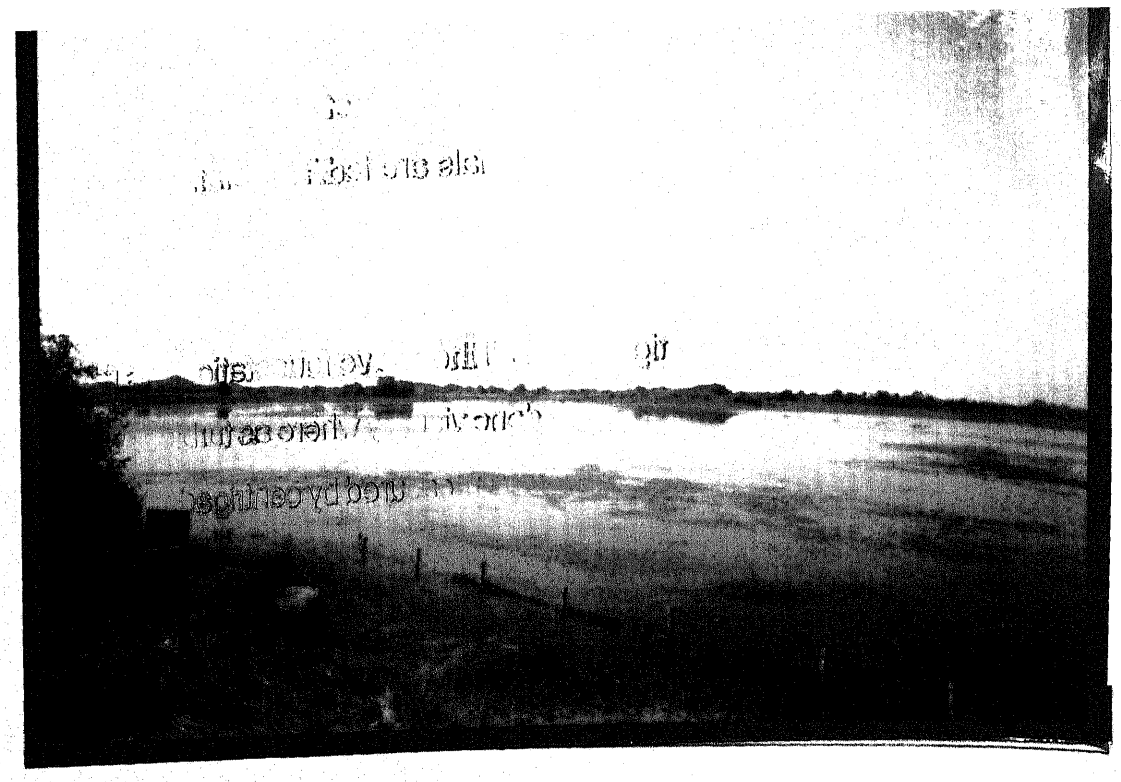
It is located on the south side where inlet is situaed. This is shallowest region whithout- embankment and trees but with marginal plants. It has an average depth of four feet at monsoon period (Plate-I).

Station A_2 :-

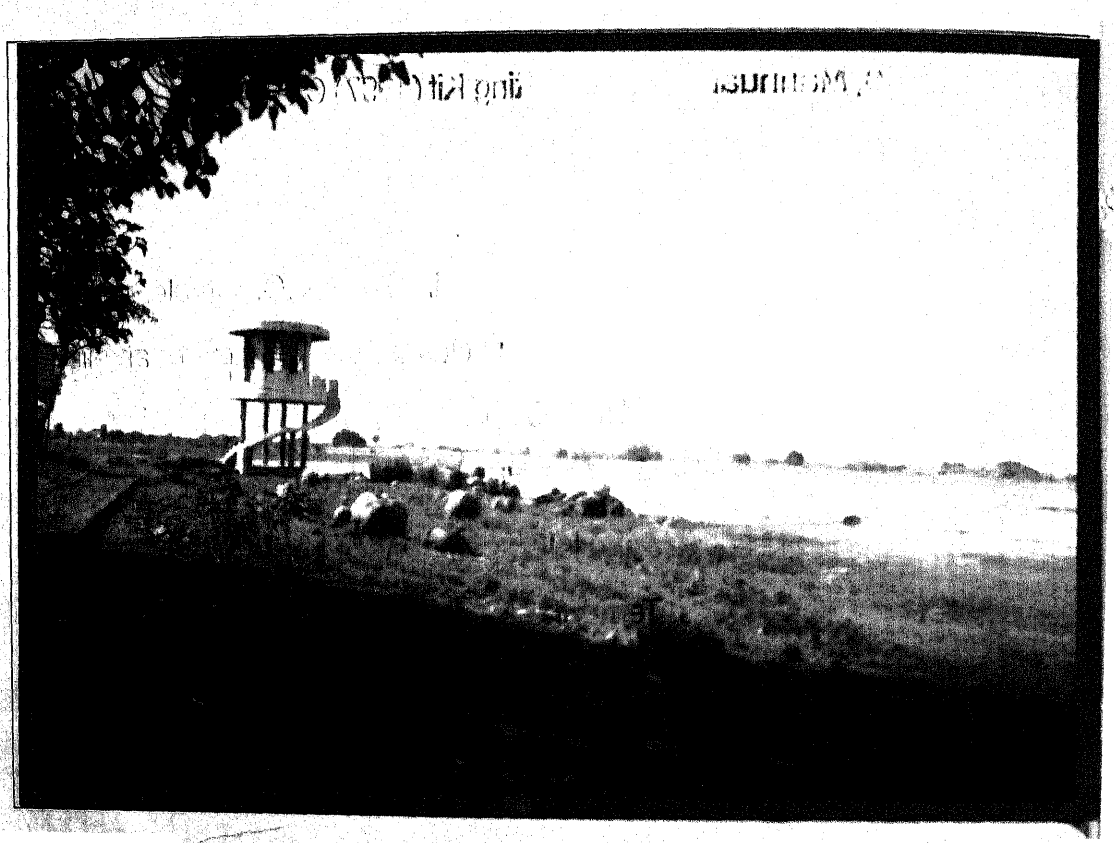
This is located on south side near bird-hide-B. It is comparatively deeper region, without embankment and trees but with marginal plants which has six feet depth during monsoon period (Plate-II).

Station A_3 :-

It is situated on eastern side. This side has embankment with trees but without marginal plants. It has 15 feet depth during monsoon period and is deepest (Plate- III).



Sampling station A_1 (near inlet) Plate-I.



Sampling station A_2 (near bird hide B) Plate-II.

Station A_4 :-

It is situated on north side and has 8 feet depth during monsoon period. It is an outlet from which two canals are fed.This station has rich aquatic vegetation (Plate- IV).

Physical investigation of all the above four stations as regards water colour and its movement were done visually where as turbidity was measured by Nephlometer, Temperature was measured by centrigade thermometer and depth was analysed by marked log.

Water sampling :-

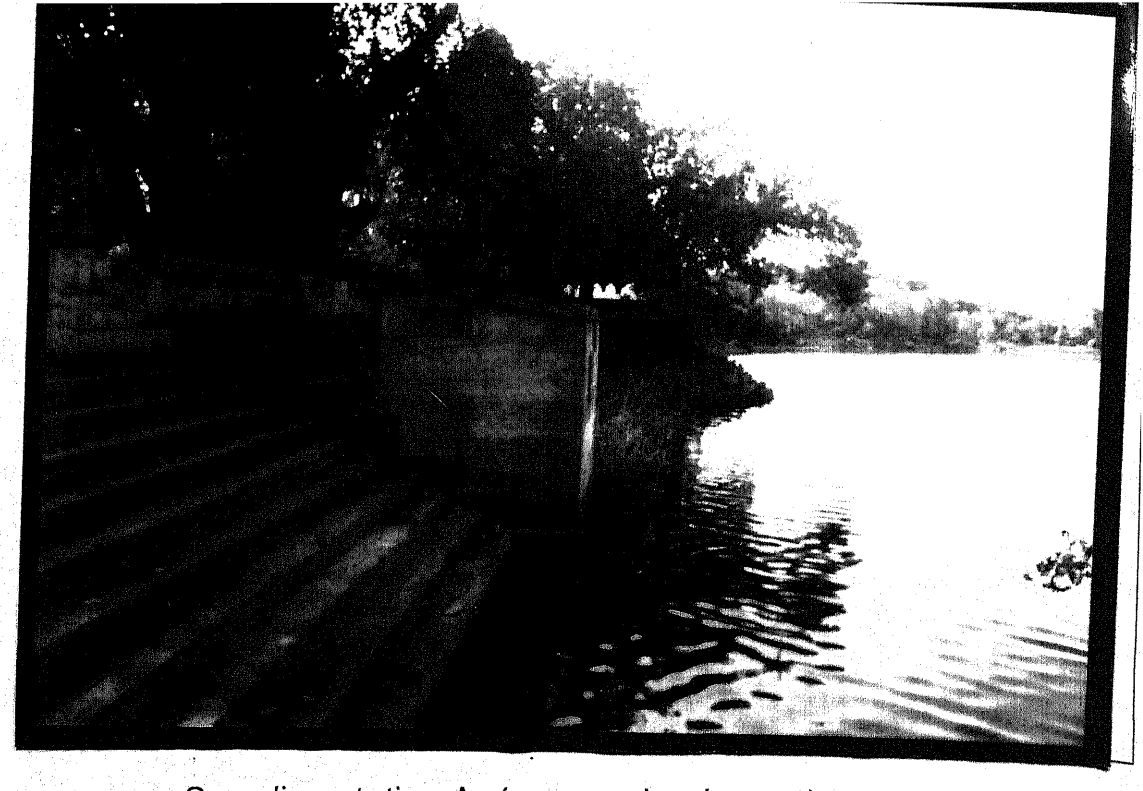
Water samples from all the four stations of Vijay sagar lake were collected monthly in forenoon for two expected years (Dec. 2001 to Nov 2003) for chemical and biological analysis. Methods adopted for analysis of related parameters were followed as per standard methods A.P.H.A (1985), Welch (1948), Mannual for water testing Kit (1997) C.P.C.B. and Trivedi and Goyal (1986) etc.

Samples for analysis were collected in D.O. sampler and good quality white polythene botteles which are cleaned properly before sampling. Samples for D.O. were collected in D.O. bottles and D.O. was fixed immediatly with 1 ml mnso4 and 1 ml of alkali iodized solution on the spot. The samples were brought immediatly to the laboratory for the estimation so that the time might not exceed 6 hours. Temperature and P.^{H} were determined at site.

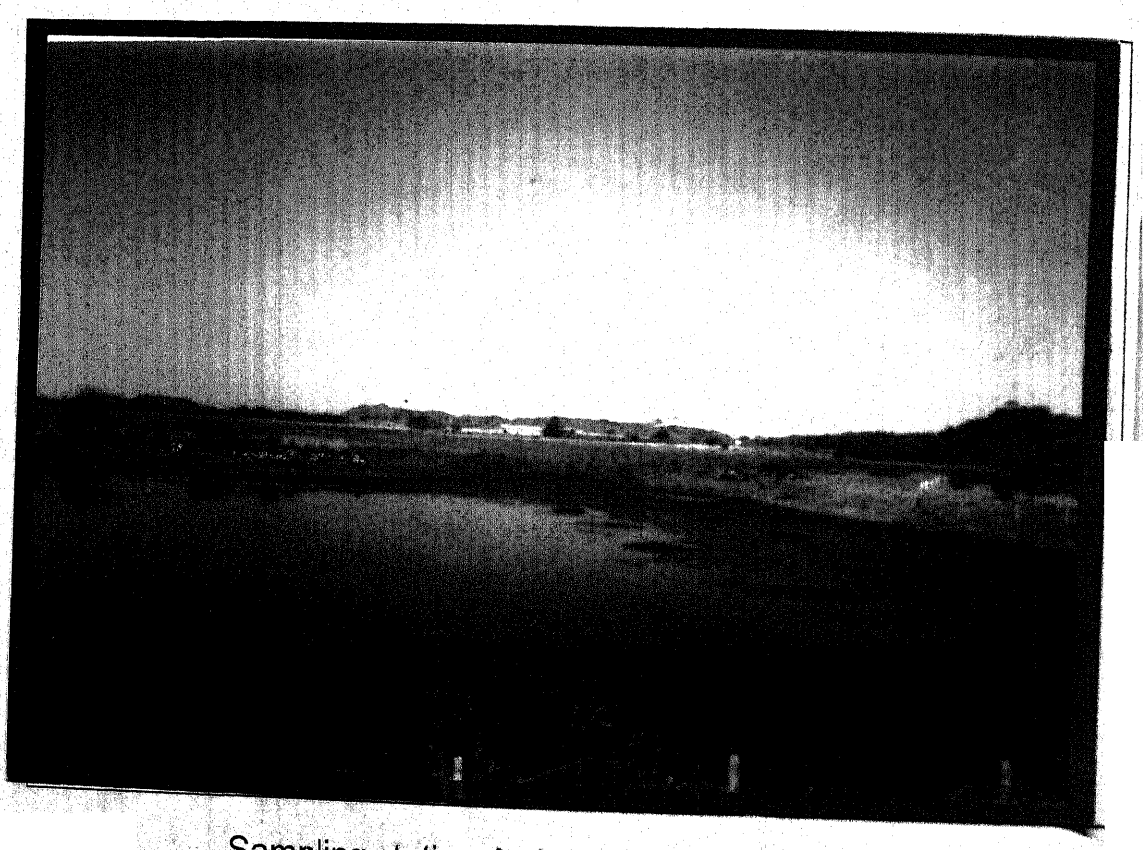
Clemical Analysis methods as per A.P.H.A. (1985)

Hydrogen-ion Concentration (p^H):-

Taken the sample from sample bottle in beaker dip the pH meter bulb in water until a constant reading is attained 4-5 minutes.



Sampling station A_3 (near embankment) Plate-III.



Sampling station A_4 (near outlet) Plate-IV.

Total alkalinity :-

Reagents (a) 0.02 N (N/5o H_2So4) :-

26.7 ml of H_2So4 was made to one litre with distilled water and standerised against 1N Na_2Co_3 solution 0.02 N H_2So_4 was prepared by making the calculated amount of standerised solution of H_2So_4 to 1 litre with distilled water.

(b) Standard 0.02 N (N/5o) Na_2CO_3 :-

To make 0.1 $Na_2 Co_3$ Stock solution 3 gm andhydrous $Na_2 Co_3$ was carefully dessicated and dissolved in one litre of distilled water. 0.02 N $Na_2 Co_3$ was prepared from the stock solution (.1N $Na_2 Co_3$) diluting it to 250 ml.

(c) Phenolphthalein (Indicator) :-

50 mg of phenolphthalein indicator was dissolved in 100ml of 50% alcohal.

(d) Methyl orange (Indicator) :-

50 mg of methyl orange indicater was dissolved in 100ml of distilled water.

Procedure :-

(1) Carbonate alkalinity :-

50 ml of the sample taken in a conical flask+2drops of phenolphthalein indicator. If the sample remains colourless (P) is present, if it turn pink titrate with 0.02 N H_2SO_4 until the pink colour disappears and note down the end point reading.

Calculation :-

P (ppm of Ca CO_3) = No. of 0.02 NH_2SO_4 x20

(2) Bicarbonate alkalinity :-

The bicarbonate (Mo) alkalinity was determined by the procedure (Vide supra) but with methyl orange, as indicator. The colour of the sample changes from yellow to faint orange that is the end point.

Calculation :-

Mo alkalinity (ppm)=No. of ml of .02 NH_2SO_4 x 20

CO_2 :-

Reagents N/44 NaOH :-

4 gm of A.R. quality NaOH is dissolved in 1 litre of distilled water, which gives 0.1 N NaoH. Standarise this solution with o1 NH_2 So4 using phenolphthalein indicator. 100 ml of this solution diluted to 440 ml gives N/44 NaOH.

Procedure :-

50 ml of water sample taken in a conical flask add 2 drops of phenolphthalein indicator. If the colour of water turns pink there in no CO_2 present. If the water is colourless, add drop by drop with the help of graduated 10 ml pipatte with gentle stirring till the colour turns pink.

Calculation :-

CO_2 (ppm) = No. of ml of N/44 NaoH required x 20

Dissolved- Oxygen :- (D.O.) (Wrinkler's method)

Reagents :- (a) Maganous sulphate :-

480 gm of MnSO4 $4H_2O$ dissolved in distilled water and made up to 1 litre.

(b) Alkaline Iodine :-

500 gm of NaOH and 150 gm KI in distilled water and add 20 gm of sodium azide and make up to 1 litre.

(c) Concentrate H_2So_4 :-

(d) Starch solution :-

Make an emulsion of 2 gm of starch in distilled water. Add this emulsion with 350 ml of boilling water in conical flask.

(e) Standard sodium thiosulphate (N/80) :-

24.82 gram of $Na_2S_2O_3$ dissolved in distilled water and diluted to 1 litre of distilled water, it gives 0.1 N $Na_2S_2O_3$ Standardise this solution with 0.1 N $K_2Cr_2O_7$ solution. 64.904 gm dissolved in 1 litre. 125 ml of this solution diluted to 1 litre gives N/80 $Na_2S_2O_3$.

Procedure :-

Carefully removed the stopper of D.O bottle and add 2ml of conc. H_2SO_4 of the solution and titrated with standard thiosulphate (N/80) to place yellow colour. Add 1 to 2 drop of freshly prepared starch solution and continued the titration to the first disappearance of blue colour.

Calculations :-

$$\text{D.O. (p.p.m.)} = \frac{1000 \times \text{No. of ml of } Na_2S_2O_3 \text{ solution}}{\text{Volume of Sample}}$$

Chloride :-

Chlorine was estimated as chlorides (Mohr's Method A.P.H.A).

Procedure :-

100 ml of the sample water was titrated with N/35.5 silver nitrate, using 5% potassium chromate $K_2 Cr.O_4$ as indicator. The end point comes when brick red colour appears.

Calculations :-

Chloride (p.p.m.) = No. of ml of N/35.5 $AgNO_3$ used X10

Ammonical nitrogen :- (Ammonia) :-

Ammonical nitrogen (NH_3-N) was estimated by visual comprison of direct Nesslerization method.

Procedure :-

Placed 50 ml of water sample in a kjeldahl distillation flask. Added approximately 0.5 gram magnesium oxide followed by 50 ml of ammonia free distilled water and distilled in Kjeldahl distillation unit. Collected 40 ml of the distillate. After making it 50 ml place it in a Nesseler's tube. This gives the ammonia present in the sample (A) to know the amount of nitrate, cool at the distillation flask after ammonia distilation Add small amount of devards alloy to the contents of the flask followed by 50 ml of ammonia free distilled water. Distilled the mixture in the similar way. Nitrate is reduced to ammonia by the devard's alloy. Collected 40 ml of distillate make up to 50 ml and keep it in the Nessler's tube. This gives the nitrate present B.

prepared a number of different nitrogen content from the standard solutin. Add 1 ml of Nessler's reagent to each and also to the two distillates (NH_3 and NO_3). Matchd the colour of both ammonia distillate (A) and nitrate distillate (B) with the colour of the standards.

Ammonical nitrgen (P.P.m.) = No. of ml of standard for (A)X.01X20

Phosphate :-

The phosphates were estimated by stannous chloride methods.

Reagents :-

(a) ammonium molybdate (acidified).

(b) Stannous chloride.

(c) Standard phosphate solution ($KH_2 PO_4$).

Procedure :-

A series of temporary standards of phosphates were prepared by adding Known volumes 0-2, 0.4, 0.6, 0.8, 1.0 and 1.2 ml of standard phosphate solution in the Nessler's tubes by adding 4 ml molybdate reagent and 1 ml stannous chloride reagent with through mixing. 50 ml sample was taken and added 4 ml molybdate reagent add 1 ml stannous chloride solution. The Colour so developed was matcdhed with the standards.

Calculalation :-

$$\text{Phosphate mg/l} = \frac{\text{Number of ml of kH2 p04 standard used X 1000}}{\text{Volume of samples}}$$

Soil Analysis :-

Soil sampling :-

Soil samples were collected with the help of Ekman's Dredge soil sampler from the bottom and placed in polythene packets. Further analysis were carried out in the laboratory. For it analysis 100 gm of the samples was kept for

drying in a oven at 40°C for about 10-15 hours in suitable sized bowl. Further grinding of dried soil was done in mortar and then it was sieved through a 20 mesh screen (Swingle 1964). The P^H value was obtained with the help of P^H meter, whereas Nitrogen, Phosphorus, and potassium were estimated, with the help of soil testing kit.

Analysis techniques:-

PH. (Hydrogen-ion concentration):-

A soil suspension was prepared to distilled water in the proportion of 1:5 (Piper-1944) and the pH was noted directly from the reading of the Systronics portable ph meter, type 322.

Nitrogen:-

(Alkaline permanganate method)

Reagents:-

(a) 0.02NH_2So_4:- 30ml of conc H_2So_4 dilluted to 1 litre with distilled water to give 1N H_2So_4 solution 20ml of this solution diluted to1litre (0.02 N H_2so_4)

(b) 0.02N NaOH :-

4 gm of NaOH dissolved in water and diluted to1litre to give 0.01N NaOH standarised against 0.1N H_2So_4. 100 ml 0.1 N NaOH standarised against 0.1 NH_2 So_4. 100 ml 0.1 N NaOH diluted to 500 ml to give 0.02 N NaOH.

(C) Methyl red indicator :-

(d) 0.38% $Kmno_4$ solution :-

Dissolved 3.8 gm of $Kmno_4$ crystals in distilled water and make up to one litre.

(e) 2.5% NaOH. solution :-

Dissolved 25 gm of NaOH in distilled water and make up to one litre.

Procedure :-

Place 10 gm of airdried powdered soil in 500 ml Kjeldahl distillation flask add 100 ml of 0.38% $Kmno_4$ solution and 100 ml of 2.5% NaoH 2ml of liquid paraffin and 10-20 glass beads and distil the mixture collecting the distillate in conical flask containing 20 ml of 0.02 N $H_2 So_4$ and few drops of methys red indicator. Collect 75 ml of the distillate, titrate the excess of 0.02 N $H_2 So_4$ with 0.02 N NaOH to a colourless end point.

Nitrogen (p.p.m.) = 20xNo. of ml of. 0.2 N NaOH X2.8

Potassium :-

Reagents. (a) Neutral normal ammonium a cetate :-

Solution of 2 N acetic acid (glacial) and 2 N ammonium hydroxide are prepared and equal volumes of the two are mixed in a large beaker and the pH adjust to 7.0 with acid or ammonium hydroxide.

Patassium chloride solution :-

A stock solution of 1000 M K/ml is made by dissolving 1.008 g of A.R KCl (dried of 60^{0c} for 1 hour) in distilled water and making up to 1 litre.

Procedure :-

5 gm of soil is shaken with 25 ml. neutral normal ammonium accetate (pH 7) for 5 minutes and filterd immediatey the rough a dry filter paper (What

mann) first few ml of the filtrate may be regected potassium cenc. In the extract is determined in the flamophotometer after necessory calibration of the instrument.

Colculation :-

$$\text{Potassium (Kg/ha)} = \frac{\text{RX volume of the extract. 22.4}}{\text{Wt. of soil taken}}$$

Phosphorus :-

(Troughs methods)

Reagents :-

(a) 0.002 N $H_2 S0_4$

(b) 50% H_2S0_4

(c) 10% Ammonium molybdate

(d) Stannous chloride

(e) Acid ammonium molybdate

(f) Satandard phosphate solution.

Procedure :-

I gram of air dried powdered soil taken in 250 ml bottle. Add 200 ml of 0.002 N H_2so_4 (pH adjusted to 3.0 ammonium- sulphate). Shake the mixture for 30 minuts in a mechanical shaker. Keep it for 10 minutes and filter. Took 50 ml of the solution in a nessler's tube, add 2ml of acid amm- molybdate reagent and 2 drops of stannous chloride, mix gently. Wait for five minutes, and match the blue clour developved with stannous phosphate solution of different concentration in phosphate free distil water.

Biological parameters :-

Analysis technique :-

Plankton :-

The phyto and zooplankton were collected by means of plankton net (welch 1948) and preserved at the site. The bolting silk No. 25 (65n) was used in the net, which is attached with an iron ring of about 20 cm diameter in conical shape. The open tail side is about 2.3 an in diameter was tied firmly to a glass tube measuring 5 cm in length and 2 cm in diameter. In each collection 100 litres of surface water was collected by means of a jug, which was filtered through the plankton net. The filtrate thus contains planktons (Phyto and zooplankton). 10 ml of the filterate was preserved in 4% formalin at the spot. The quantitative and qualitative examination was done in the laboratory by the standard methods (A.P.H.A. 1985 18th Ed.) and Goyal and Trivedi 1986.

Before analysis each plankton sample was diluted and mixed with water to make it to 50 ml, 1 ml of this subsample was drawn quickly with a wide mouthed pipette and poured into a Sedgewick-Rafter plankton counting cell. All the organisms were identified up to genus level. Analysis of each genus was then calculated as No/litre of the water by the formula given by welch's (1948).

$$n = \frac{(ax1000).c}{l}$$

where,

n= No. of plankton per lit.

a= average No. of plankton in all count in a counting cell.

c= Volume of original concentrate expressed in lit.

I= Volume of original water expressed in litre.

Fishes :-

The fishes were collected during night or early in the morning by line and bait method and also with vertical nets (100'x5') with a mesh (3'x5') in diameter and its identified with the help of Francis Day fauna.

Aquatic weeds :-

The samples of aquatic weeds were collected and their abundance was assessed by visual observations and identified up to species level according to Hooker (1872-1997) and Subramanyam (1962).

Meteorological data are recorded from telegraph office in Mahoba district and its mean values was calculated.

OBSERVATION

OBSERVATION

In the present study characteristics of water and soil conditions of Vijay sagar lake were studied for the period of two years (from Dec 2001 up to Nov. 2003). As regards this the parameters which were considered are : Abiotic factors depth, colour, movement, temperature, tubidity, pH, carbonate, biacarbonate total alkalinity, D.O. Co_2, ammonical- nitrogen, phosphat ; biotic factors- plankton, aquatic weeds and economically important fishes and soil Conditions- pH, nitrogen, phosphorus and potassium.

Besides, meteoreological conditions were also recorded. All the above factors were observed monthly and their seasonal variations have also been mentioned.

Meteoreological conditions :-

Regarding these conditions atmospheric temperature, rainfall, humidity and photoperiod were taken and their monthly mean value have been recorded during the period of two years study which are as under :

Atmospheric temperature :-

During the period of 2001- 02 it varied between 8.5°C to 41.3°C and in 2002-03 ranged between 7.°C to 41.5°C. The lowest atmospheric temperature was recoded in the month of winter season (January) whereas highest was observed in the month of summer season (June) Thus the same conditions were noticed in both the years of study (table 1 & 2 fig 2 & 3.)

Rainfall :

In the first year 2001-02 varied from 3.8 mm to 248.32mm and in second year 2002-03 is ranged between 1.0mm and 134.60mm. hence lowest

rainfall was recorded in the month of Dec. While the highest was observed in August in both the years wheres in the months of Jan, March, Oct, and Nov. 2001- 02 rainfall was nil and in the months of Jan, April, May and Nov. 2002-03 rainfall was also nil . (table 1 & 2 Fig 2 & 3.)

Relative humidity :-

It varied from 20.12% to 81.16% during 2001-02 and in 2002-03 ranged between 16.17% to 79.93%. Lowest humidity was recorded in may while the highest was observed in August in both the years . (table 1 & 2 fig 2 & 3.)

Photoperiod :-

It varied between 10.20 hrs. and13.30 hrs. in 2001-02 and in 2002-03 ranged between10.18 hrs. and 13.20 hrs. Lowest photoperiod was recorded in Dec while the highest was observed in may both the years. (table 1 & 2 fig 2 & 3.)

Abiotic factors :

These include physical and chemical factors of water. The parameters related with these which were taken in the present study are physical- water movement, depth, turbidity, colour, water temperature, chemical - , pH, carbonate, bicarbonate, total alkalinity, D.O. Co_2, Chloride, ammonical nitrogen and phosphate.

5. Water movement :-

The maximum movement of lake water was found in the months of summer season (May and June) due to high wind velocity and rainy season (July and August) ; whereas the movement of water in winter season was recorded minimum.

6. Depth :-

The maximum depth 15feet was measured in the months of monsoon season (July and Aug.), due to rainfall, while minimum depth in the months of summer season (May and June) due to high evaporation of water.

7. Turbidity :-

It varied from 12.30 to 70.12 N.T.U. during the 2001-2002 and 13.86 to 64.65 N.T.U in the 2002-2003, Maximum turbidity was observed in the month of July and August. While the minimum average value was observed in the month of January both the years. The higher trend of turbidity was observed during monsoon and summer season. (Table 3 to 10 fig 4 to 11).

8. Colour :-

The colour of water was found to vary from greenish to green & muddy. The greenish and green colour of the water in the months of Feb, March and Oct & in July and August months the muddy colour was found whereas in September month water became muddy-green in both. the year. (Table 3 to 10).

Water temperature :-

It varied from 16.0 ^{oc} to 32.90 ^{oc} in 2001-02 and between 15.9 ^{oc} to 33.0 ^{oc} in the year 2002-03 at four sampling stations. Lowest temperature of water was recorded in winter i.e. Dec. and January. While the highest was recorded in summer in May and June. The range of fluctuation of temperature was found very little at the four different sampling stations. (Table 3 to 10 fig 4 to 11).

PH :-

The PH value was observed in the alkaline range throughout the study period. During the present study period of 2001-2002 varied between 7.68 to

8.40 and in 2002-03 ranged between 7.80 to 8.20 maximum average value was recorded in the month of September while the minimum average value was recorded in the month of Dec. (Tabel.3 to 10 fig.4 to 11).

Carbonate :-

In the first year 2001-2002 it varied from 6.6 to 19.8 ppm. and in 2002- 03 ranged between 5.7 to 18.9 ppm. minimum average value was recorded in the month of Sept while the maximum average value was recorded in the month of June in both the Years. (Table 3 to 10 fig 12 to 19).

Bicarbonate :-

In the first year 2001-2002 it varied from 132.4 to 196.2 ppm and in 2002-03 ranged between 133.4 to 196.2 ppm maximum average value was recorded in the month of Nov. while the minimum average value was recorded in the month of May and June (Table 3 to 10 fig 12 to 19).

Total alkalinety :-

It varied from 143.3 to 214.9ppm 2001-02 and in 2002-03 ranged between 142.0 to 211.1 ppm minimum average value was recorded in the month of Nov. while the maximum average value was recorded in the month of June. (Table 3 to 10 fig 12 to 19).

Chloride :-

In the first year 2001-02 it was found 16.0 to 50.2 ppm and in 2002-03 ranged between 12.4 to 48.4 ppm maximum average value was recorded in the month of June while the minimum average value was recorded in the months of August and Spt (Table 3 to 10 fig 12 to 19).

D.O.:-

It was found 3.1 to 8.0 ppm in 2001-02 and in 2002-03 ranged between 4.2 to 8.6 ppm maximum average value was recorded in the months of Dec. and Jan. while the minimum average value was recorded in the month of June (Table 3 to 10 fig 20 to 27).

Co_2 :-

In the first year 2001- 02 it varied from 8.9 to 19.8 ppm and in 2002-03 ranged between 8.6 to 19.6 ppm. Maximum average value was recorded in the month of June while the minimum average value was recoded in the months of Dec. and January. (Table 3 to 10 fig 20 to 27).

Phosphate :-

It varied between 0.20 to 0.66 ppm in 2001-02 and in 2002-03 ranged between 0.23 to 0.69 ppm. Maximum average value was recorded in the month of August while the minimum value was recorded in the month of November.(Table 3 to 10 fig 20 to 27).

Ammonical nitrogen :-

In the first year 2001-02 it varied between 0.21 to 0.80 ppm and in 2002- 03 ranged between 0.22 to 0.79 ppm. Maximum mean value was recorded in the month of June. while the minimum mean value was recorded in the months of November and Decmber. (Table 3 to 10 fig 20 to 27).

Biotic factors

Biotic features of the Vijay sagar lake which were considered here in the period of study are aquatic weeds, plankton (phytoplankton and zooplankton) and economically iportant fishes :

Aquatic weeds :-

These were observed monthly during both the years and available species are summarised under following categories :-

1-	Ipomea aquatic	--	M
2-	Nelumbo spp	--	Fixed, F
3-	Potamogeton indicus	--	E
4-	Najas minor	--	S
5-	Eliocharis spp.	--	M.E.
6-	Spirodella polyriza	--	F.F.
7-	Polygonum glabrum	--	M.
8-	Ceratophyllum demersum	--	S.
9-	Pistia spp.	--	
10-	Vallisnaria spiralis	--	S.
11-	Lemna cicostata	--	F.F.
12-	Azolla spp.	--	F.F.
13-	Cyperus spp.	--	M.
14-	Hydrilla spp.	--	S.

M, Marginal

S, Submerged

E, Emergent

Fixed floating

ME, Marginal emergent

FF, Free floating

Fishes :

The economically important fishes were dragged out and they were indentified monthly during the investigation period. They are :

1-	Labeo rohita	--	Column fecder, planktophage
2-	Labeo calbasu	--	Omnivorus, ditritus feeder.
3-	Catla catla	--	Surface feeder, planktophage
4-	Cirrihinus mrigala	--	Bottom feeder, Herbivore
5-	Wallago attu	--	Carnivorus and predeceous
6-	Channa marulius	--	Carnivorous, predceous.
7-	Mystus seenghala	--	predacious and carnivorous, column and bottom feeder.
8-	Clarius batrachus	--	Bottom feeder, carnivorous
9-	Heteropneustes fossilis	--	Bottom feeder, Omnivore
10-	Xenetodon cancila	--	
11-	Ctenopharyngodon idella	--	Column feeder, Herbivore,
12-	Chanda nama	--	Carivorous, Surface or column feeder
13-	Chanda ranga	--	Insectivorous, surface feeder

PLANKTON :

(A) PhytoPlankton :-

In the present observation only dominant groups of phytoplankton were studied, quantitatively and qualitatively and indentified up to genus as follows:-

Group (a) Chlorophyceae :- Mainly nine genera i.e.

(i) Coelastrum (ii) Ulothrix (iii) Spirogyra (iv)Zygnema (v) Pediastrum (vi) Tetraspora (vii) Scnedesmus (viii) Actinastrum (ix) Protococcus

.

Group chlorophyceae varied from 112 org/l to 465 org/i during the period of 2001-02 and in 2002-03 varied from 85 org/l to 452 org/l. (table 11 to 18).

Group (b) Bacillariophyceae :-

Mainly seven genera i.e. (i) Cyclotella (ii) Frustulia (iii) Navicula (iv) synedra (v) Diatoma (vi)Amphora (vii) Nitzschia.

Group Bacillariophyceae varied from 117 org/l to 270 org/l during the period of 2001-02 and in 2002-03 varied from 112 org/l to 264 org/l (Table11 to 18).

Group (c) Myxophyceae :-

Mainly five genera i.e. (i) Microcystis (ii) Oscillatoria (iii) Nostoc (iv) Anabaena (v) Tetrapedia.

Group myxophyceae varied from 99 org/l to 389 org/l during the period of 2001-02 and in 2002-03 varied from 72 org/l to 333 org/l (table 11 to 18)

The population of phytoplankton has been presented in tables.

(B) Zooplankton :-

The zooplankton population mainly consists of protozoans, Rotifers and planktonic froms of crustaceans (Jhingran, 1977). In the present investigation only dominat groups of zooplankton were studied, qualitatively and quantitatively and identified up to genus as follows :-

Group (a) Rotifera :-

Mainly 6 genera i.e. (i) Brachionus (ii) Filinia (iii) Keratella (iv) Testudinella (v) Philodina (vi) Asplachna.

Group rotifera varied from 18 org/l to 155 org/l during the period of 2001-02 and in 2002-03 varied from 10 org/l to 154 org/l. (table 19 to 26)

Group (b) Crustacea :- (1) Copepoda and egg Nauplii :-

Mainly three genera i.e. (i) Cyclops (ii) Mesocyclops (iii) Diaptomus, besides eggs and nauplii.

Subgroup copepoda and egg nauplii varied from 28 org/l to 93 during the period of 2001-02 and in 2002-03 varied from 26 org/l to 85 org/l . (table 14 to 26)

(2) Cladocera (subgroup) :-

Mainly four genera i.e. (i) Daphnia (ii) Cirrodaphnia (iii) Diaphanosoma (iv) Alonella

Subgroup cladocera varied from 05 org/l to 162 org/l during the period of 2001-02 and in 200-03 varied from 09 org/l to 129 org/l (table14 to 26).

Group (C) Protozoa :-

Mainly five genera i.e. (i) Paramecium (ii) Vorticella (iii) Arcella (iv) Euglypha (v) Euglena.

Group protozoa varied from 16 org/l to 68 org/l during the period of 2001-02 and in 2002-03 varied from 19 org/l to 72 org/l. (table 14 to 26) The population of zooplankton has been presented tin tables.

Chemical conditions of lake soil :-

The soil of the Vijay sagar lake was analysed during the study period and their chemical factors are mentioned as under :-

pH :-

In the first year 2001-02 varied between 7.8 to 8.6 and in 2002-03 ranged between 8.0 to 8.7, maximum mean value was recorded in the months of November and, May while the minimum mean value was recorded in the months of December, July and September. (table 27 & 28).

Nitrogen:-

It varied between very low (VL. 20 ppm) to high (H.0.80 ppm) in 2001-02 and in 2002- 03 ranged between very low (VL. 0.26 ppm) to high (H. 0.86 ppm) maximum average value was recorded in the months of March, April and May while the minimum mean value was recorded in the months od Nov. July and August. (table 27 & 28).

Potassium :-

In the first year 2001-02 it varied between low (L,100 ppm) to high (H, 400 ppm) and in 2002-03 ranged between low (98 ppm) to high (331 ppm)

maximum average value was recorded in the months of February, March and May while the minimum average value was found in the month of September. (table 27 & 28)

Phosphorus :-

It varied between low (L., 20 ppm) to high (H, 40.0 ppm) in 2001-02 and in 2002-03 ranged between low (L., 18.0 ppm) to high (H, 42. ppm) maximum average value was recorded in the months of November, December, July,August and May while the minimum average value was recorded in month of April (table 27 & 28)

Table - 1

Meteorological Data

(Monthly average, December 2001- November-2002)

S.No.	Month	Atmospheric temp.		Relative Humidity (%)		Monthly rain fall ((mm)/%	Photo period (Hrs.)
		Maximum (0^0C)	Minimum (0^0C)	Morning	Evening		
1	December	23.2	10.0	32.22	24.21	0	10.20
2	January	23.9	8.5	32.18	25.16	0	10.30
3	February	28.5	12.5	40.21	27.58	9.8	11.10
4	March	39.0	17.5	30.16	22.12	0	11.35
5	April	41.3	23.4	38.81	26.18	7	12.45
6	May	40.6	28.3	33.99	22.34	3.9	13.30
7	June	39.8	29.0	32.96	20.21	3.8	13.34
8	July	38.3	28.5	46.68	29.11	25.47	13.25
9	August	32.5	25.6	81.16	68.06	248.32	12.56
10	September	31.4	24.2	54.56	32.18	86.31	11.51
11	October	30.0	20.5	46.66	20.12	0	11.00
12	November	27.5	15.1	44.31	27.56	0	10.45

The data were obtained from the telegraph office Mahoba.

Table - 2

Meteorological Data

(Monthly average, December 2002- November-2003)

S.No.	Month	Atmospheric temp.		Relative Humidity (%)		Monthly rain fall ((mm)/%	Photo period (Hrs.)
		Maximum (0^0C)	Minimum (0^0C)	Morning	Evening		
1	December	24.1	10.9	40.45	26.31	1.00	10.18
2	January	18.2	7	54.55	32.50	0.00	10.22
3	February	23.9	17.8	52.45	30.12	16.40	11.10
4	March	32.2	16.4	40.00	28.10	2.53	11.42
5	April	38.7	23.1	35.12	27.62	0.00	12.33
6	May	40.7	25.9	30.15	16.17	0.00	13.02
7	June	41.5	28.6	55.02	34.46	65.50	13.20
8	July	34.2	29.3	65.54	55.06	96.60	13.16
9	August	33.2	27.3	79.13	59.41	134.60	12.46
10	September	32.0	25.5	55.21	36.16	80.65	11.74
11	October	28.1	21.3	51.21	30.16	36.54	11.22
12	November	27.2	18.4	49.64	27.1	0.00	10.52

The data were obtained from the telegraph office Mahoba.

Table- 3

Physico--Chemical Factors

Station-A_1

Period : 2001-2002

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.90	18.26	Green	7.69	17.90	140.10	158.00	21.40	0.29	0.22	7.60	9.4
2	January	16.00	14.21	Green	7.90	15.90	142.40	157.90	26.40	0.31	0.29	7.20	9.0
3	February	22.60	15.00	Greenish	8.00	13.40	160.20	173.60	29.20	0.30	0.29	6.90	10.20
4	March	25.00	16.12	Greenish	8.00	11.50	170.10	181.60	33.60	0.39	0.32	6.20	16.1
5	April	29.90	19.98	Green	8.00	14.90	172.20	187.10	32.60	0.43	0.40	5.00	16.0
6	May	31.40	20.12	Green	8.02	15.80	176.00	191.80	30.40	0.62	0.58	4.10	17.2
7	June	32.40	32.16	Green	8.06	18.90	196.20	214.90	46.20	0.82	0.60	3.10	19.8
8	July	30.90	39.35	Muddy	7.68	12.60	190.20	202.80	39.20	0.59	0.65	4.20	16.6
9	August	30.10	62.35	Muddy	8.16	8.90	188.20	197.10	20.20	0.60	0.65	6.10	16.4
10	September	30.40	55.12	Muddy green	8.19	6.80	150.20	157.00	16.20	0.32	0.29	6.00	12.2
11	October	28.30	34.40	Greenish	7.98	9.60	138.40	148.00	26.10	0.26	0.26	5.90	11.6
12	November	24.90	29.02	Green	8.00	13.90	133.40	146.30	30.40	0.27	0.26	6.80	10.2

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- I

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_1

Period 2001-02

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonica Initrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.61	1.00									
Hydrogenion Conceration	-0.09	-0.061	1.00								
Carbonate	-0.13	-0.38	0.97	1.00							
Bicarbonate	0.18	0.29	-0.98	-0.94	1.00						
Tatol alkalinity	0.174	0.274	0.998	-0.944	0.999	1.00					
Chloride	0.238	-0.311	-0.047	0.101	0.132	0.138	1.00				
Ammonicalnitrogen	-0.090	-0.252	1.000	0.966	-0.986	-0.987	-0.389	1.00			
Phosphate	-0.090	-0.252	1.00	0.966	-0.986	-0.983	-0.390	1.00	1.00		
Dissolved oxygen	-0.139	-0.264	0.998	0.961	-0.992	-0.993	-0.428	0.998	0.998	1.00	
Carbon dioxide	0.040	-0.189	0.974	0.945	-0.929	-0.932	-0.267	0.975	0.974	0.958	1.00

Table- 4

Physico--Chemical Factors

Station-A_2

Period : 2001-2002

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.80	16.12	Green	8.06	17.60	142.60	160.20	22.00	0.37	0.32	7.70	9.40
2	January	16.40	13.00	Green	8.00	15.20	145.90	161.10	28.00	0.39	0.36	7.90	9.00
3	February	22.20	14.02	Greenish	8.00	13.80	158.10	171.90	31.40	0.47	0.40	7.10	10.70
4	March	25.40	15.16	Greenish	8.01	11.00	168.20	179.20	39.50	0.54	0.48	6.20	15.90
5	April	29.60	18.56	Green	8.02	14.60	170.20	184.80	25.70	0.59	0.55	4.70	16.10
6	May	31.60	19.46	Green	8.16	15.50	178.20	193.70	32.60	0.69	0.60	4.10	17.90
7	June	32.20	28.12	Green	8.12	18.60	189.10	207.70	48.70	0.80	0.62	3.20	18.90
8	July	30.10	45.02	Muddy	7.96	12.40	186.20	198.60	32.60	0.69	0.66	4.80	17.00
9	August	29.50	65.35	Muddy	8.16	11.20	180.20	191.20	40.70	0.60	0.58	6.10	16.90
10	September	30.20	61.24	Muddy green	8.18	9.80	140.40	150.20	34.90	0.56	0.52	6.20	14.30
11	October	28.00	61.20	Greenish	8.02	9.00	138.40	147.40	19.90	0.36	0.34	6.20	12.60
12	November	24.50	31.12	Green	8.07	13.20	136.20	149.40	16.00	0.24	0.22	7.20	8.90

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- II

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_2 Period 2001-02

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonica Initrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.197	1.00									
Hydrogenion Conceration	0.038	-0.337	1.00								
Carbonate	0.057	-0.429	0.984	1.00							
Bicarbonate	0.720	0.257	-0.939	-0.955	1.00						
Tatol alkalinity	0.011	0.302	0.985	-0.898	0.945	1.00					
Chloride	-0.625	0.021	-0.257	-0.243	0.215	0.209	1.00				
Ammonicalnitrogen	0.013	-0.339	0.991	0.912	-0.945	-0.943	-0.426	1.00			
Phosphate	0.024	-0.343	0.991	0.912	-0.945	-0.938	-0.427	1.00	1.00		
Dissolved oxygen	0.012	-0.334	0.992	0.914	-0.942	-0.940	-0.437	0.997	0.998	1.00	
Carbon dioxide	0.059	-0.315	0.953	0.865	-0.930	-0.943	-0.290	0.976	0.976	0.959	1.00

Table-29

Statistical Values of Vijay Sagar Lake at Station-A_1

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	26.90	4.82	32.40	16.00	26.90	4.68	32.40	16.40	26.90	4.75	32.40	16.20
2	Tarbidity	29.60	15.25	62.35	14.21	30.81	16.24	64.64	13.96	30.20	15.75	63.49	14.08
3	Hydrogen-ion-concentration	7.98	0.15	8.19	7.68	8.04	0.09	8.20	7.82	7.90	0.12	8.19	7.75
4	Carbonate	12.30	3.51	18.90	6.80	11.40	3.38	18.00	6.80	11.85	3.45	18.40	6.80
5	Bicarbonate	163.13	21.18	196.20	133.40	159.70	22.39	196.20	136.30	161.40	21.79	196.20	134.80
6	Total Alkalinity	176.34	21.92	214.90	146.30	179.50	21.22	203.00	143.60	177.90	21.57	208.90	144.80
7	Chloride	29.30	7.91	46.20	16.20	28.90	8.99	48.20	12.40	29.10	8.54	47.20	14.30
8	Ammonical nitrogen	0.43	0.17	0.82	0.27	0.40	0.15	0.69	0.22	0.41	0.16	0.75	0.24
9	Phosphate	0.40	0.16	0.65	0.22	0.42	0.16	0.68	0.25	0.41	0.16	0.66	0.23
10	Dissolved oxygen	5.75	1.33	8.00	3.10	6.18	1.07	8.60	4.20	5.96	1.20	8.30	3.65
11	Carbon-di-oxide	13.72	3.51	19.80	8.90	13.26	3.63	19.60	8.60	13.49	3.57	19.70	8.75

Table- 5

Physico--Chemical Factors

Station-A_3

Period : 2001-2002

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.10	15.03	Green	7.80	17.00	140.60	147.60	19.90	0.24	0.26	7.90	9.00
2	January	16.60	12.30	Green	8.16	15.60	137.30	152.90	28.20	0.29	0.26	8.00	8.90
3	February	21.70	13.02	Greenish	8.00	12.30	155.00	167.30	30.40	0.40	0.39	7.20	10.20
4	March	24.90	14.00	Greenish	8.06	14.20	165.20	179.40	38.20	0.40	0.42	6.40	14.10
5	April	28.10	18.12	Green	7.92	9.50	168.20	177.70	25.40	0.51	0.54	5.20	15.20
6	May	30.90	19.32	Green	7.98	16.00	172.10	188.10	32.60	0.60	0.50	4.90	16.90
7	June	31.90	30.16	Dirty	8.16	19.60	185.10	204.70	46.40	0.71	0.50	3.30	19.60
8	July	29.80	40.68	Green	7.95	10.40	189.20	199.60	36.10	0.50	0.56	6.50	18.10
9	August	28.90	60.23	Muddy	8.09	9.00	190.60	199.60	19.90	0.32	0.57	6.60	15.20
10	September	29.80	52.32	Muddy green	8.12	7.20	146.60	153.80	16.60	0.26	0.27	6.50	13.90
11	October	27.60	32.46	Greenish	7.90	6.90	136.40	143.30	24.30	0.24	0.23	6.30	12.00
12	November	24.00	30.00	Green	8.12	11.60	132.40	144.90	34.10	0.22	0.20	7.90	10.00

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- III

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_3 Period 2001-02

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonica lnitrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.582	1.00									
Hydrogenion Conceration	-0.074	-0.145	1.00								
Carbonate	-0.128	-0.284	0.970	1.00							
Bicarbonate	0.174	0.199	-0.987	-0.944	1.00						
Tatol alkalinity	0.169	0.187	0.988	-0.939	0.999	1.00					
Chloride	0.211	0.293	-0.141	0.021	0.196	0.213	1.00				
Ammonicalnitrogen	-0.071	-0.252	0.999	0.961	-0.987	-0.988	-0.383	1.00			
Phosphate	-0.071	-0.146	0.999	0.960	-0.987	-0.988	-0.385	0.999	1.00		
Dissolved oxygen	-0.122	-0.153	0.998	0.954	-0.992	-0.093	-0.412	0.997	0.997	1.00	
Carbon dioxide	0.131	-0.054	0.973	0.938	-0.931	-0.931	-0.278	0.994	0.973	0.957	1.00

Table- 6

Physico--Chemical Factors

Station-A_4

Period : 2001-2002

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.30	18.16	Green	8.03	18.00	142.40	160.40	21.10	0.36	0.39	7.20	9.10
2	January	16.20	14.26	Green	8.36	16.00	143.20	159.20	29.60	0.39	0.46	7.40	9.00
3	February	21.90	16.40	Greenish	8.05	13.90	152.20	166.10	31.60	0.46	0.59	7.00	10.40
4	March	23.90	17.50	Greenish	8.05	13.00	160.30	173.30	39.80	0.51	0.56	6.10	15.00
5	April	29.50	19.12	Green	8.41	16.90	170.60	187.50	20.70	0.57	0.64	4.90	16.20
6	May	31.90	20.22	Green	8.06	19.80	170.80	190.60	31.60	0.68	0.66	4.00	17.10
7	June	32.90	32.12	Green	7.95	12.20	182.20	194.40	50.20	0.78	0.60	3.20	19.30
8	July	30.40	42.26	Muddy	8.32	10.90	190.30	201.20	38.20	0.59	0.62	4.30	18.10
9	August	29.10	70.12	Muddy	8.40	6.90	190.20	197.10	24.40	0.32	0.66	6.00	16.80
10	September	30.50	56.24	Muddy green	8.26	6.60	149.10	154.80	18.00	0.31	0.32	5.90	12.50
11	October	28.50	35.26	Greenish	8.13	10.40	138.90	149.30	27.20	0.23	0.26	6.20	11.90
12	November	24.60	32.00	Green	8.18	14.20	135.30	149.50	34.20	0.21	0.25	7.40	10.40

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- IV

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_4

Period 2001-02

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonical Initrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.530	1.00									
Hydrogenion Conceration	-0.157	-0.296	1.00								
Carbonate	-0.238	-0.497	0.965	1.00							
Bicarbonate	0.243	0.365	-0.989	-0.954	1.00						
Tatol alkalinity	0.267	0.343	0.991	-0.947	0.999	1.00					
Chloride	0.206	-0.104	-0.267	-0.238	0.306	0.304	1.00				
Ammonicalnitrogen	-0.154	-0.301	0.999	0.954	-0.989	-0.991	-0.465	1.00			
Phosphate	-0.215	-0.299	0.999	0.954	-0.989	-0.991	-0.467	0.999	1.00		
Dissolved oxygen	-0.206	-0.307	0.998	0.953	-0.994	0.996	-0.492	0.997	0.997	1.00	
Carbon dioxide	0.041	-0.214	0.971	0.913	-0.930	-0.936	-0.358	0.975	0.971	0.953	1.00

Table-30

Statistical Values of Vijay Sagar Lake Station-A_2

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	26.70	4.69	32.20	16.40	27.08	4.69	33.00	16.40	26.89	4.69	32.60	16.40
2	Tarbidity	32.36	19.50	65.35	13.00	30.91	16.34	63.46	13.86	31.63	17.92	64.40	13.43
3	Hydrogen-ion-concentration	8.06	0.07	8.18	7.96	8.04	0.07	8.19	7.96	8.05	0.07	8.18	7.96
4	Carbonate	13.49	2.85	18.60	9.00	11.87	3.02	13.60	7.10	12.68	2.94	18.10	8.00
5	Bicarbonate	161.14	19.04	189.10	136.20	160.60	19.12	189.20	135.60	160.80	19.08	189.10	135.90
6	Total Alkalinity	172.40	20.01	207.70	147.40	172.50	17.75	198.40	147.30	172.40	18.88	203.00	147.30
7	Chloride	31.00	8.97	48.70	16.00	30.00	7.84	48.40	19.20	30.50	8.41	48.50	17.60
8	Ammonical nitrogen	0.52	0.16	0.80	0.24	0.45	0.13	0.69	0.26	0.48	0.15	0.74	0.25
9	Phosphate	0.47	0.13	0.62	0.22	0.45	0.14	0.69	0.24	0.46	0.14	0.65	0.23
10	Dissolved oxygen	5.95	1.41	7.90	3.20	6.24	1.15	8.40	4.30	6.09	1.28	8.15	3.75
11	Carbon-di-oxide	13.90	3.53	18.90	8.90	13.69	3.48	19.40	9.00	13.79	3.51	19.15	8.95

Table-7

Physico--Chemical Factors

Station-A_1

Period : 2002-2003

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	21.00	19.40	Green	7.82	18.00	142.20	160.20	22.40	0.22	0.25	7.20	9.00
2	January	16.40	13.96	Green	8.00	16.00	140.40	156.40	27.00	0.31	0.33	7.30	9.20
3	February	22.90	14.24	Greenish	8.00	13.90	158.20	172.10	30.20	0.33	0.33	6.90	10.20
4	March	24.60	15.98	Greenish	8.02	12.20	167.40	179.60	33.60	0.36	0.32	6.20	16.40
5	April	28.90	19.21	Green	8.20	9.20	176.30	185.50	29.00	0.44	0.40	5.80	16.00
6	May	30.40	20.24	Green	8.06	6.80	196.20	203.00	30.90	0.61	0.60	5.10	17.20
7	June	32.40	36.12	Green	8.05	8.50	190.30	198.80	48.20	0.69	0.62	4.30	18.50
8	July	31.00	40.45	Muddy	8.02	12.30	190.40	202.70	40.50	0.61	0.66	4.90	16.40
9	August	30.20	64.65	Muddy	8.06	9.20	144.20	153.40	12.40	0.43	0.68	5.40	16.40
10	September	31.00	56.98	Muddy green	8.16	7.20	136.40	143.60	19.40	0.34	0.32	6.20	10.40
11	October	29.00	38.45	Greenish	7.98	10.40	138.30	148.70	24.00	0.29	0.26	6.90	10.60
12	November	25.90	30.12	Green	8.00	14.00	136.30	150.30	30.20	0.24	0.29	8.00	8.90

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- V

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_1 Period 2002-03

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonical Initrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.654	1.00									
Hydrogenion Conceration	-0.231	-0.291	1.00								
Carbonate	-0.393	-0.382	0.970	1.00							
Bicarbonate	0.305	0.252	-0.985	-0.975	1.00						
Tatol alkalinity	0.281	0.245	0.989	-0.972	0.999	1.00					
Chloride	0.210	-0.319	-0.093	-0.098	0.212	0.202	1.00				
Ammonicalnitrogen	-0.230	-0.291	0.999	0.972	-0.985	-0.988	-0.326	1.00			
Phosphate	-0.230	-0.290	0.999	0.972	-0.985	-0.988	-0.327	1.00	1.00		
Dissolved oxygen	-0.267	-0.307	0.998	0.979	-0.991	-0.993	-0.348	0.998	0.932	1.00	
Carbon dioxide	-0.078	-0.246	0.471	0.911	-0.925	-0.434	-0.022	0.972	0.930	0.985	1.00

Table- 8

Physico--Chemical Factors

Station-A_2

Period : 2002-2003

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	21.20	19.45	Green	7.96	17.06	145.20	162.80	21.40	0.31	0.32	7.60	9.00
2	January	16.40	13.86	Green	8.00	16.30	144.20	160.50	27.40	0.36	0.34	8.40	9.20
3	February	22.90	14.26	Greenish	8.00	14.20	150.20	164.40	30.20	0.39	0.36	6.90	10.20
4	March	25.20	15.96	Greenish	8.01	13.20	163.20	176.40	34.40	0.47	0.42	6.20	15.20
5	April	28.70	19.16	Green	8.19	12.20	170.40	182.60	29.10	0.51	0.52	5.90	15.90
6	May	30.20	20.17	Green	8.00	9.40	178.20	187.60	30.10	0.59	0.57	5.10	16.90
7	June	33.00	35.98	Green	8.00	9.20	189.20	198.40	48.40	0.69	0.60	4.30	18.00
8	July	31.10	40.26	Muddy	8.10	10.00	188.00	198.00	41.20	0.65	0.67	4.90	19.40
9	August	30.20	63.46	Muddy	8.06	8.90	180.60	189.50	30.20	0.52	0.69	5.40	16.10
10	September	31.00	59.24	Muddy green	8.16	7.10	146.20	153.30	19.20	0.39	0.36	6.20	12.20
11	October	29.20	38.21	Greenish	7.99	10.30	137.00	147.30	23.90	0.36	0.36	6.90	11.60
12	November	25.90	31.00	Green	8.10	14.10	135.60	149.70	25.60	0.26	0.24	7.10	10.60

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- VI

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_2 Period 2002-03

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonical Initrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.654	1.00									
Hydrogenion Conceration	-0.252	-0.294	1.00								
Carbonate	-0.432	-0.421	0.982	1.00							
Bicarbonate	0.333	0.320	-0.989	-0.982	1.00						
Tatol alkalinity	0.304	0.301	0.992	-0.979	0.999	1.00					
Chloride	0.428	0.033	-0.242	-0.286	0.347	0.334	1.00				
Ammonicalnitrogen	-0.234	-0.295	0.999	0.976	-0.984	-0.992	-0.472	1.00			
Phosphate	-0.051	-0.294	0.999	0.976	-0.989	-0.992	-0.472	1.00	1.00		
Dissolved oxygen	-0.298	-0.316	0.998	0.984	-0.994	-0.996	-0.507	0.998	0.998	1.00	
Carbon dioxide	-0.073	-0.222	0.972	0.417	-0.932	-0.940	-0.308	0.973	0.973	0.957	1.00

Table-31

Statistical Values of Vijay Sagar Lake Station-A_3

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	26.10	4.56	31.90	16.60	25.80	4.49	32.20	16.90	25.90	4.53	32.05	16.70
2	Tarbidity	28.13	15.35	60.23	12.30	31.13	16.04	60.16	14.12	29.63	15.70	60.19	13.27
3	Hydrogen-ion-concentration	8.02	0.11	8.16	7.80	8.04	0.08	8.15	7.92	8.03	0.10	8.15	7.92
4	Carbonate	12.40	3.89	19.60	6.90	11.68	3.48	18.40	5.70	12.04	3.69	19.00	6.30
5	Bicarbonate	159.80	20.56	190.60	132.40	161.06	18.61	190.10	133.40	160.40	19.59	190.50	132.90
6	Total Alkalinity	171.15	22.00	204.70	143.30	172.90	20.26	208.50	142.00	172.00	21.13	206.60	142.50
7	Chloride	29.30	8.33	46.40	16.60	27.40	7.14	37.20	15.20	28.35	7.74	41.80	15.90
8	Ammonical nitrogen	0.39	0.15	0.71	0.22	0.51	0.17	0.79	0.26	0.45	0.16	0.75	0.24
9	Phosphate	0.39	0.14	0.57	0.20	0.47	0.14	0.68	0.23	0.43	0.14	0.62	0.21
10	Dissolved oxygen	6.39	1.33	8.00	3.30	6.41	1.27	8.60	4.20	6.40	1.30	8.30	3.75
11	Carbon-di-oxide	13.59	3.45	19.60	8.90	14.27	3.45	19.60	9.00	13.93	3.45	19.60	8.90

Table- 9

Physico--Chemical Factors

Station-A_3

Period : 2002-2003

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.10	16.00	Green	8.15	14.00	146.20	160.20	20.00	0.33	0.34	7.60	9.10
2	January	16.90	15.00	Green	8.14	13.30	148.20	161.50	26.10	0.36	0.34	8.50	9.00
3	February	21.40	14.12	Greenish	8.00	14.20	150.60	164.80	29.40	0.46	0.42	7.20	10.00
4	March	23.40	14.19	Greenish	8.00	10.30	164.50	174.70	35.60	0.50	0.52	6.90	15.20
5	April	27.30	20.46	Green	7.98	9.90	170.60	180.50	32.10	0.60	0.57	5.00	15.90
6	May	30.90	21.42	Green	7.92	16.10	172.40	188.50	32.40	0.62	0.64	5.00	16.80
7	June	32.20	46.56	Green	8.00	18.40	190.10	208.50	37.20	0.79	0.60	4.20	19.60
8	July	29.20	46.16	Muddy	8.10	11.40	189.20	200.60	36.20	0.78	0.68	5.10	19.00
9	August	28.90	60.16	Muddy	8.00	10.50	180.20	190.70	19.40	0.67	0.68	6.40	18.00
10	September	29.00	53.02	Muddy green	8.14	5.70	149.20	157.40	15.20	0.46	0.43	6.50	15.20
11	October	26.90	36.42	Greenish	7.95	7.90	138.20	146.10	24.10	0.38	0.36	6.60	12.90
12	November	24.10	30.12	Green	8.12	8.60	133.40	142.00	21.10	0.26	0.23	7.90	10.20

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- VII

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_3

Period 2002-03

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonica lnitrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.680	1.00									
Hydrogenion Conceration	-0.003	-0.312	1.00								
Carbonate	0.003	-0.361	0.978	1.00							
Bicarbonate	0.089	0.361	-0.936	-0.946	1.00						
Tatol alkalinity	0.083	0.353	0.990	-0.442	0.999	1.00					
Chloride	0.242	-0.283	0.100	0.231	-0.015	-0.012	1.00				
Ammonicalnitrogen	0.002	-0.310	0.999	0.971	-0.989	-0.989	-0.208	1.00			
Phosphate	0.001	-0.311	0.999	0.971	-0.937	-0.99	-0.209	1.00	1.00		
Dissolved oxygen	-0.053	-0.334	0.998	0.965	-0.995	-0.995	-0.245	0.997	0.998	1.00	
Carbon dioxide	0.228	-0.145	0.965	0.945	-0.925	0.927	-0.088	0.967	0.967	0.948	1.00

Table- 10

Physico--Chemical Factors

Station-A_4

Period : 2002-2003

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.10	16.96	Green	8.11	14.20	145.30	159.50	21.00	0.26	0.26	8.00	8.90
2	January	15.90	15.21	Green	8.16	13.60	146.90	160.50	26.00	0.29	0.26	8.20	8.60
3	February	22.40	14.12	Greenish	8.00	13.90	153.60	167.50	28.90	0.32	0.30	7.20	10.20
4	March	23.90	15.00	Greenish	8.00	10.20	165.20	175.40	34.40	0.42	0.39	7.00	10.60
5	April	27.20	21.49	Green	7.86	9.60	172.40	181.60	34.10	0.58	0.52	6.90	13.00
6	May	30.90	22.46	Green	7.80	15.20	180.20	195.40	33.60	0.62	0.60	5.40	16.90
7	June	32.40	33.21	Green	8.00	18.90	192.20	211.10	46.20	0.75	0.61	4.20	19.30
8	July	30.10	62.40	Muddy	8.12	10.60	188.20	198.80	20.20	0.69	0.66	6.20	18.20
9	August	28.90	55.16	Muddy	8.16	9.20	180.10	189.30	16.20	0.58	0.65	6.90	16.70
10	September	28.90	48.21	Muddy green	8.10	11.80	180.20	191.90	19.20	0.36	0.32	6.90	16.00
11	October	25.80	39.42	Greenish	7.98	8.10	159.20	167.30	24.20	0.32	0.30	7.20	12.80
12	November	24.10	35.12	Green	8.12	8.90	138.60	147.50	31.40	0.26	0.23	7.80	10.90

All value in ppm (mg/l) except temperature in degree Centigrade and Turbidity in N.T.U.

Table- VIII

Matrix Showing Correlation of Coefficient among various Physico-chemical Parameters

Station-A_3 Period 2002-03

	Water Temperature (°C)	Turbidity (N.T.U.)	Hydrogenion Conceration	Carbonate (ppm)	Bicarbonate (ppm)	Tatol alkalinity (ppm)	Chloride (ppm)	Ammonica Initrogen	Phosphate (ppm)	Dissolved oxygen (ppm)	Carbon dioxide (ppm)
Water Temperature	1.00										
Turbidity	0.589	1.00									
Hydrogenion Conceration	-0.009	-0.332	1.00								
Carbonate	0.111	-0.390	-0.982	1.00							
Bicarbonate	0.114	0.394	-0.992	-0.962	1.00						
Tatol alkalinity	0.099	0.383	-0.992	-0.958	0.999	1.00					
Chloride	0.217	-0.459	0.019	0.130	-0.006	-0.004	1.00				
Ammonicalnitrogen	-0.002	-0.332	0.999	0.976	-0.991	-0.991	-0.247	1.00			
Phosphate	-0.002	-0.332	0.999	0.976	-0.992	-0.992	-0.248	1.00	1.00		
Dissolved oxygen	-0.049	-0.346	0.998	0.969	-0.996	-0.996	-0.276	0.998	0.498	1.00	
Carbon dioxide	0.218	-0.107	0.970	0.958	-0.937	-0.938	-0.216	0.892	0.972	0.958	1.00

Table-32

Statistical Values of Vijay Sagar Lake Station-A_4

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	26.64	4.97	32.90	16.20	25.80	4.57	32.40	15.90	26.22	4.77	32.65	16.05
2	Tarbidity	31.13	16.86	70.12	14.26	31.56	15.88	62.40	14.12	31.30	16.37	66.20	14.19
3	Hydrogen-ion-concentration	8.18	0.15	8.40	7.95	8.03	0.11	8 16	7.80	8.10	0.13	8.78	7.87
4	Carbonate	12.40	3.95	19.80	6.60	12.01	3.06	18.90	8.10	12.20	3.51	19.33	7.35
5	Bicarbonate	160.25	19.10	190.30	135.30	166.84	17.22	192.60	138.60	163.50	18.16	191.40	136.90
6	Total Alkalinity	160.95	20.54	201.20	149.30	178.80	18.18	211.10	147.50	169.80	19.36	206.10	148.40
7	Chloride	30.50	8.85	50.20	18.00	27.95	8.16	46.20	16.20	29.22	8.51	48.20	17.10
8	Ammonical nitrogen	0.45	0.17	0.78	0.21	0.45	0.17	0.75	0.26	0.45	0.17	0.60	0.23
9	Phosphate	0.50	0.15	0.66	0.25	0.42	0.16	0.66	0.23	0.46	0.16	0.66	0.24
10	Dissolved oxygen	5.80	1.35	7.40	3.20	6.82	1.07	8.20	4.20	6.31	1.21	7.80	3.70
11	Carbon-di-oxide	13.80	3.53	19.30	9.00	13.50	3.60	19.30	8.60	13.66	3.57	19.30	8.80

Table- 11

Monthly Variation of Phytoplankton

Station-A_1 **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	16	13	11	0	7	0	0	0	6	3	0	0
2	Ulothrix	51	46	37	26	14	0	0	0	0	18	6	0
3	Spirogyra	2	3	0	0	0	0	0	5	0	4	4	3
4	Zygnema	14	15	15	16	10	23	24	5	9	17	18	14
5	Pediastrum	25	43	40	35	66	53	66	0	15	21	30	22
6	Tetraspora	35	25	28	35	55	38	34	32	18	20	29	35
7	Scnedesmus	25	22	24	35	22	32	33	19	30	44	25	26
8	Actinastrum	5	3	7	13	17	0	13	15	26	0	4	0
9	Protococcus	120	190	195	204	220	285	295	32	27	64	30	124
	Total	**293**	**360**	**357**	**364**	**411**	**431**	**465**	**108**	**131**	**191**	**146**	**224**
Bacillariophyceae													
1	Cyclotella	28	24	22	20	34	37	34	40	0	0	15	24
2	Frustulia	0	4	5	0	0	5	0	7	9	0	10	5
3	Navicula	45	50	58	73	72	79	75	40	38	49	56	63
4	Synedra	28	24	32	39	42	52	50	30	23	45	20	22
5	Diatoma	13	15	15	7	0	0	17	0	20	0	0	0
6	Amphora	0	0	0	21	50	29	25	10	15	22	13	0
7	Nitzschia	45	42	39	38	62	64	69	12	18	30	30	35
	Total	**159**	**159**	**171**	**198**	**260**	**266**	**270**	**139**	**123**	**146**	**144**	**149**
Myxophyceae													
1	Microcystis	150	122	145	215	219	251	269	85	60	100	135	140
2	Oscillatoria	8	0	0	0	0	23	44	50	30	25	23	16
3	Nostoc	14	0	10	20	19	23	18	22	20	14	0	15
4	Anabaena	0	0	0	0	7	8	11	12	14	9	0	0
5	Tetrapedia	0	25	20	11	0	0	18	25	22	14	15	14
	Total	**172**	**147**	**175**	**246**	**245**	**305**	**360**	**194**	**146**	**162**	**173**	**185**
	Grand Total	**624**	**666**	**703**	**808**	**916**	**1002**	**1095**	**441**	**400**	**499**	**463**	**558**

Table- 12

Monthly Variation of Phytoplankton

Station-A_2 **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	18	12	10	2	7	3	0	0	8	5	1	0
2	Ulothrix	53	48	39	28	16	2	0	0	0	20	8	0
3	Spirogyra	4	6	2	0	0	0	0	8	0	6	4	4
4	Zygnema	16	18	18	16	0	15	11	7	9	19	20	15
5	Pediastrum	27	46	42	38	69	55	69	0	16	22	32	24
6	Tetraspora	37	27	30	38	56	39	36	33	19	22	31	37
7	Scnedesmus	26	23	26	37	20	34	36	39	42	46	26	28
8	Actinastrum	6	4	9	15	19	6	0	15	28	22	0	0
9	Protococcus	122	180	198	200	224	230	246	49	40	56	59	128
	Total	**309**	**364**	**374**	**374**	**411**	**384**	**398**	**151**	**162**	**218**	**181**	**236**
Bacillariophyceae													
1	Cyclotella	28	26	24	22	36	39	38	36	0	0	18	28
2	Frustulia	0	5	7	0	0	7	0	9	11	0	12	6
3	Navicula	38	32	59	75	55	61	57	13	12	70	58	64
4	Synedra	40	36	44	40	44	54	52	18	15	47	22	24
5	Diatoma	17	14	16	8	0	0	9	0	22	0	0	0
6	Amphora	0	0	0	22	52	20	16	19	27	24	14	0
7	Nitzschia	27	33	40	59	55	56	60	23	30	32	32	38
	Total	**150**	**146**	**190**	**226**	**242**	**237**	**232**	**118**	**117**	**173**	**156**	**160**
Myxophyceae													
1	Microcystis	152	122	141	214	220	261	260	87	108	120	136	140
2	Oscillatoria	8	0	0	0	0	24	44	52	31	25	24	18
3	Nostoc	10	0	10	21	20	22	18	25	20	16	0	16
4	Anabaena	0	0	0	0	0	9	10	12	14	16	10	0
5	Tetrapedia	0	27	22	12	0	0	10	27	26	16	16	13
	Total	**170**	**149**	**173**	**247**	**240**	**316**	**342**	**203**	**199**	**193**	**186**	**187**
	Grand Total	**629**	**659**	**737**	**847**	**893**	**937**	**972**	**472**	**478**	**584**	**523**	**583**

Table- 13

Monthly Variation of Phytoplankton

Station-A_3 **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	14	13	10	0	6	0	0	0	5	3	0	0
2	Ulothrix	50	45	36	25	12	0	0	0	0	17	5	10
3	Spirogyra	2	1	0	0	0	0	0	4	0	4	3	2
4	Zygnema	13	12	12	15	0	6	10	5	8	16	17	12
5	Pediastrum	25	42	38	32	64	51	64	6	12	20	30	21
6	Tetraspora	32	22	26	32	55	36	32	30	18	21	27	32
7	Scnedesmus	25	20	23	32	20	31	32	36	38	43	21	22
8	Actinastrum	4	2	6	12	15	2	0	11	22	20	0	0
9	Protococcus	120	180	190	200	218	243	263	70	65	83	112	120
	Total	**285**	**337**	**341**	**348**	**390**	**369**	**401**	**162**	**168**	**227**	**215**	**219**
Bacillariophyceae													
1	Cyclotella	26	23	20	18	32	34	30	30	0	0	12	22
2	Frustulia	0	3	4	0	0	4	0	6	8	0	8	5
3	Navicula	33	40	40	40	50	57	59	28	36	43	53	64
4	Synedra	35	32	41	36	40	51	48	36	51	44	21	20
5	Diatoma	12	10	12	6	0	0	5	0	11	0	0	0
6	Amphora	0	0	0	20	48	36	38	10	14	20	12	0
7	Nitzschia	33	38	48	56	61	70	78	20	6	29	29	31
	Total	**139**	**146**	**165**	**176**	**231**	**252**	**258**	**130**	**126**	**136**	**135**	**142**
Myxophyceae													
1	Microcystis	148	120	140	213	216	258	260	32	28	122	130	139
2	Oscillatoria	6	0	0	0	0	22	43	48	29	21	21	14
3	Nostoc	12	0	8	10	12	13	16	20	10	11	0	6
4	Anabaena	0	0	0	0	0	5	10	11	12	13	6	0
5	Tetrapedia	0	12	18	10	0	0	16	23	20	12	13	11
	Total	**166**	**132**	**166**	**233**	**228**	**298**	**345**	**134**	**99**	**179**	**170**	**170**
	Grand Total	**590**	**615**	**672**	**757**	**849**	**919**	**1004**	**426**	**393**	**542**	**520**	**531**

Table- 14

Monthly Variation of Phytoplankton

Station-A_4

Period : 2001-2002

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	22	15	12	4	9	5	0	0	10	8	2	2
2	Ulothrix	55	49	41	29	18	5	0	0	0	26	12	0
3	Spirogyra	6	10	5	0	0	0	0	9	0	7	4	4
4	Zygnema	19	20	20	18	0	17	13	9	12	20	22	16
5	Pediastrum	29	48	46	39	62	59	71	0	16	26	39	28
6	Tetraspora	39	29	32	41	39	39	36	18	25	18	26	36
7	Scnedesmus	30	28	26	39	21	38	38	21	15	49	29	36
8	Actinastrum	10	6	11	17	23	9	0	17	32	24	0	0
9	Protococcus	120	190	195	203	220	292	298	38	29	69	65	129
	Total	**330**	**395**	**388**	**390**	**392**	**464**	**456**	**112**	**139**	**247**	**199**	**251**
Bacillariophyceae													
1	Cyclotella	30	26	25	29	38	42	38	37	0	0	0	26
2	Frustulia	0	6	9	0	0	9	0	11	13	0	15	8
3	Navicula	40	42	45	43	56	65	59	35	40	60	58	65
4	Synedra	45	39	46	40	47	60	58	49	58	49	58	65
5	Diatoma	20	18	15	9	0	0	9	0	26	0	0	0
6	Amphora	0	0	0	26	59	26	19	21	29	26	19	0
7	Nitzschia	30	38	45	59	68	68	72	26	12	35	35	40
	Total	**165**	**169**	**185**	**206**	**268**	**270**	**255**	**179**	**178**	**170**	**185**	**204**
Myxophyceae													
1	Microcystis	146	126	141	216	215	246	256	80	92	96	109	148
2	Oscillatoria	10	0	0	0	0	28	26	32	36	28	26	20
3	Nostoc	16	0	12	35	24	26	18	22	21	15	0	18
4	Anabaena	0	0	0	0	0	11	12	14	16	18	12	0
5	Tetrapedia	0	29	22	13	0	0	21	29	23	17	18	14
	Total	**172**	**155**	**175**	**264**	**239**	**311**	**333**	**177**	**188**	**174**	**165**	**200**
	Grand Total	**667**	**719**	**748**	**860**	**899**	**1045**	**1044**	**468**	**505**	**591**	**549**	**655**

Table- 15

Monthly Variation of Phytoplankton

Station-A_1

Period : 2002-2003

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	16	14	10	0	5	0	0	0	5	4	0	0
2	Ulothrix	52	45	36	25	13	0	0	0	0	16	6	0
3	Spirogyra	2	3	0	0	0	0	0	5	0	6	4	3
4	Zygnema	14	16	16	18	0	12	12	6	9	19	19	20
5	Pediastrum	26	45	41	37	67	56	67	0	14	22	31	25
6	Tetraspora	37	27	29	37	56	39	37	33	20	22	30	38
7	Scnedesmus	26	23	26	37	23	36	38	22	30	49	25	27
8	Actinastrum	6	4	3	12	18	6	0	12	26	20	0	0
9	Protococcus	110	180	185	203	225	285	298	36	28	33	35	103
	Total	**289**	**357**	**346**	**369**	**407**	**434**	**452**	**114**	**132**	**191**	**150**	**216**
Bacillariophyceae													
1	Cyclotella	26	25	25	21	35	39	36	20	0	0	16	26
2	Frustulia	0	5	6	0	0	5	0	8	9	0	12	4
3	Navicula	36	40	46	49	55	61	64	23	30	50	51	52
4	Synedra	35	82	43	32	41	55	53	41	51	43	20	26
5	Diatoma	16	12	15	6	0	0	9	0	22	0	0	0
6	Amphora	0	0	0	21	53	22	16	13	31	26	14	0
7	Nitzschia	30	30	41	46	45	44	42	20	22	31	32	36
	Total	**143**	**194**	**176**	**175**	**229**	**226**	**220**	**125**	**165**	**150**	**145**	**144**
Myxophyceae													
1	Microcystis	120	126	140	189	220	236	242	27	21	120	138	141
2	Oscillatoria	9	0	0	0	0	22	45	32	31	26	22	19
3	Nostoc	12	0	10	16	14	20	10	12	16	20	14	0
4	Anabaena	0	0	0	0	0	6	9	12	14	14	9	0
5	Tetrapedia	0	22	21	10	0	0	19	26	23	15	15	12
	Total	**141**	**148**	**171**	**215**	**234**	**284**	**325**	**109**	**105**	**195**	**198**	**172**
	Grand Total	**573**	**699**	**693**	**759**	**870**	**944**	**997**	**348**	**402**	**536**	**493**	**532**

Table- 16

Monthly Variation of Phytoplankton

Station-A_2 **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	19	12	10	3	8	4	0	0	6	5	2	0
2	Ulothrix	54	49	40	26	19	1	0	0	0	21	9	0
3	Spirogyra	5	7	1	0	0	0	0	6	0	5	5	4
4	Zygnema	16	19	19	17	0	19	11	9	9	21	22	16
5	Pediastrum	27	46	43	39	69	56	70	0	15	21	31	23
6	Tetraspora	36	26	31	39	56	41	39	36	20	21	32	39
7	Scnedesmus	29	24	27	39	20	34	37	40	41	47	29	32
8	Actinastrum	6	5	11	19	23	4	0	12	29	22	0	0
9	Protococcus	126	120	190	206	226	289	294	39	28	67	62	123
	Total	**318**	**308**	**372**	**388**	**421**	**448**	**451**	**142**	**148**	**230**	**192**	**237**
Bacillariophyceae													
1	Cyclotella	29	27	26	23	39	41	39	37	0	0	0	29
2	Frustulia	0	6	9	0	0	6	0	8	11	0	12	6
3	Navicula	40	43	46	49	59	62	59	35	35	65	59	69
4	Synedra	41	35	46	43	45	59	54	46	57	49	21	23
5	Diatoma	16	15	14	6	0	0	9	0	12	0	0	0
6	Amphora	0	0	0	21	55	21	17	20	26	32	16	0
7	Nitzschia	30	35	43	59	66	69	63	30	31	32	36	39
	Total	**156**	**161**	**184**	**201**	**264**	**258**	**241**	**176**	**172**	**178**	**144**	**166**
Myxophyceae													
1	Microcystis	150	134	145	216	222	242	232	59	30	92	17	145
2	Oscillatoria	9	0	0	0	0	25	49	53	32	26	29	20
3	Nostoc	16	0	11	31	21	29	20	29	22	17	0	16
4	Anabaena	0	0	0	0	0	9	11	14	16	20	10	0
5	Tetrapedia	0	16	25	12	0	0	21	26	21	14	16	12
	Total	**175**	**150**	**181**	**259**	**243**	**305**	**333**	**181**	**121**	**169**	**72**	**193**
	Grand Total	**649**	**619**	**737**	**848**	**928**	**1011**	**1025**	**499**	**441**	**577**	**408**	**596**

Table- 17

Monthly Variation of Phytoplankton

Station-A_3

Period : 2002-2003

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	10	12	10	0	5	0	0	0	4	2	0	0
2	Ulothrix	53	48	32	29	16	0	0	0	0	16	10	0
3	Spirogyra	1	1	0	0	0	0	0	2	0	2	3	2
4	Zygnema	12	10	10	14	0	10	12	5	6	15	16	12
5	Pediastrum	23	41	36	31	60	52	60	0	10	19	31	20
6	Tetraspora	30	21	24	30	53	31	30	16	19	21	29	32
7	Scnedesmus	25	21	26	36	21	35	37	20	20	45	21	23
8	Actinastrum	5	4	6	14	15	6	0	10	20	20	0	0
9	Protococcus	110	160	175	185	220	269	268	32	29	39	39	88
	Total	**269**	**318**	**319**	**339**	**390**	**403**	**407**	**85**	**108**	**179**	**149**	**177**
Bacillariophyceae													
1	Cyclotella	22	23	19	16	30	39	35	38	0	0	10	19
2	Frustulia	0	2	3	0	0	5	0	6	9	9	6	4
3	Navicula	36	39	40	43	56	59	63	30	30	60	54	69
4	Synedra	36	33	43	31	40	50	43	17	20	30	26	20
5	Diatoma	12	11	14	5	0	0	5	0	25	0	0	0
6	Amphora	0	0	0	21	46	37	12	16	21	0	14	0
7	Nitzschia	32	31	43	45	46	40	46	20	22	21	22	18
	Total	**138**	**139**	**162**	**161**	**218**	**230**	**204**	**127**	**127**	**120**	**132**	**130**
Myxophyceae													
1	Microcystis	125	126	140	160	210	235	240	26	29	120	118	126
2	Oscillatoria	4	0	0	0	0	21	39	29	26	22	23	19
3	Nostoc	11	0	6	25	14	14	20	15	22	18	10	12
4	Anabaena	0	0	0	0	0	4	9	10	12	16	6	0
5	Tetrapedia	0	20	19	10	0	0	14	20	23	10	12	16
	Total	**140**	**146**	**165**	**195**	**224**	**274**	**322**	**100**	**112**	**186**	**169**	**173**
	Grand Total	**547**	**603**	**646**	**695**	**832**	**907**	**933**	**312**	**347**	**485**	**450**	**480**

Table- 18

Monthly Variation of Phytoplankton

Station-A_4

Period : 2002-2003

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	21	16	12	5	10	6	0	0	12	9	4	2
2	Ulothrix	60	50	43	32	22	6	0	0	0	21	10	0
3	Spirogyra	8	12	4	0	0	0	0	6	0	8	4	6
4	Zygnema	20	22	21	16	0	16	12	8	10	19	24	15
5	Pediastrum	26	46	45	37	73	60	72	0	14	25	30	27
6	Tetraspora	36	28	30	42	50	30	40	37	34	16	25	36
7	Scnedesmus	29	25	27	37	20	36	36	26	26	39	32	30
8	Actinastrum	10	5	10	16	26	12	0	15	31	23	0	0
9	Protococcus	112	165	166	174	226	246	265	38	32	43	43	100
	Total	**322**	**369**	**358**	**359**	**427**	**412**	**425**	**130**	**159**	**203**	**172**	**216**
Bacillariophyceae													
1	Cyclotella	32	25	25	26	37	41	39	38	0	0	0	2
2	Frustulia	0	5	7	0	0	6	0	10	12	0	14	6
3	Navicula	37	32	42	51	52	60	68	30	33	46	53	64
4	Synedra	43	36	42	41	45	61	63	32	32	26	25	27
5	Diatoma	20	22	0	14	11	0	0	0	16	14	11	13
6	Amphora	21	16	14	8	0	0	6	0	21	0	0	0
7	Nitzschia	0	0	0	23	39	26	14	21	26	26	16	0
	Total	**153**	**136**	**130**	**163**	**184**	**194**	**190**	**131**	**140**	**112**	**119**	**112**
Myxophyceae													
1	Microcystis	116	126	142	164	221	236	36	30	30	106	121	146
2	Oscillatoria	6	0	0	0	0	24	43	34	32	26	25	22
3	Nostoc	12	0	10	31	23	25	25	16	18	20	14	16
4	Anabaena	0	0	0	0	0	10	10	12	14	17	19	0
5	Tetrapedia	0	13	20	10	0	0	20	21	25	14	16	11
	Total	**134**	**139**	**172**	**205**	**244**	**295**	**134**	**113**	**119**	**183**	**195**	**195**
	Grand Total	**609**	**644**	**660**	**727**	**855**	**901**	**749**	**374**	**418**	**498**	**486**	**523**

Table- 19

Monthly Variation of Zooplankton

Station-A_1 **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	4	5	5	6	8	10	12	2	2	1	2	5
2	Verticella	5	4	5	4	6	6	7	0	0	2	3	4
3	Arcella	2	2	3	4	2	3	6	2	0	0	2	2
4	Euglypha	6	4	9	2	10	4	3	2	0	0	5	6
5	Euglena	15	29	35	34	36	33	36	21	18	32	28	30
	Total	**32**	**44**	**57**	**50**	**62**	**56**	**64**	**27**	**20**	**35**	**40**	**47**
Rotifera													
1	Brachionus	16	14	16	18	31	28	38	10	11	18	35	39
2	Filinia	3	0	2	4	3	5	9	15	11	21	24	29
3	Keretella	0	0	0	0	0	0	18	8	9	13	14	12
4	Testudinella	0	0	0	0	6	12	14	18	22	24	28	33
5	Philodina	2	4	3	0	4	5	10	11	12	19	22	28
6	Asplanchna	4	3	4	2	3	6	7	0	0	0	0	3
	Total	**25**	**21**	**25**	**24**	**47**	**56**	**96**	**62**	**65**	**95**	**123**	**144**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	10	4	7	14	20	23	30	10	12	8	10	13
2	Mesocyclops	0	0	0	0	0	0	0	4	6	8	10	15
3	Diaptomus	0	0	0	0	0	0	0	0	0	0	0	0
4	Eggs & Nauplii	20	26	30	28	50	46	63	29	20	26	26	23
	Total	**30**	**30**	**37**	**42**	**70**	**69**	**93**	**43**	**38**	**42**	**46**	**51**
(b)	**Cladocerans**												
1	Daphnia	5	6	15	17	26	28	29	4	0	0	4	6
2	Ceriodaphnia	0	0	0	14	17	50	49	20	16	16	22	6
3	Diaphanosoma	0	0	10	10	16	19	32	10	8	16	23	9
4	Alonella	6	2	3	7	10	19	36	12	6	8	12	6
	Total	**11**	**8**	**28**	**48**	**69**	**116**	**146**	**46**	**30**	**40**	**61**	**27**
	Grand Total	**98**	**103**	**147**	**164**	**248**	**297**	**399**	**178**	**153**	**212**	**270**	**269**

Table- 20

Monthly Variation of Zooplankton

Station-A_2 **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	6	10	10	6	9	10	12	4	3	1	3	5
2	Verticella	6	5	7	6	9	8	7	0	0	2	4	5
3	Arcella	4	4	3	6	2	3	6	2	0	0	2	2
4	Euglypha	6	9	9	4	10	6	4	3	0	0	4	6
5	Euglena	19	32	39	36	35	32	38	34	19	17	19	27
	Total	**41**	**60**	**68**	**58**	**65**	**59**	**67**	**43**	**22**	**20**	**32**	**45**
Rotifera													
1	Brachionus	18	14	15	18	31	36	42	18	16	13	26	36
2	Filinia	3	0	2	4	5	3	8	12	9	21	21	26
3	Keretella	0	0	0	0	0	0	13	8	9	12	14	12
4	Testudinella	0	0	0	0	6	10	13	18	21	21	26	30
5	Philodina	3	4	6	2	4	5	11	12	11	16	20	29
6	Asplanchna	4	4	3	2	4	6	6	0	0	0	0	6
	Total	**28**	**22**	**26**	**26**	**50**	**60**	**93**	**68**	**66**	**83**	**107**	**139**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	12	5	6	16	25	26	29	29	15	9	11	14
2	Mesocyclops	0	0	0	0	0	0	0	4	8	12	16	18
3	Diaptomus	3	8	6	2	5	5	6	4	1	3	3	5
4	Eggs & Nauplii	18	24	26	25	46	46	46	26	20	26	22	26
	Total	**33**	**37**	**38**	**43**	**76**	**77**	**81**	**63**	**44**	**50**	**52**	**63**
(b)	**Cladocerans**												
1	Daphnia	4	9	13	16	24	26	29	3	0	0	0	2
2	Ceriodaphnia	0	0	0	12	16	46	48	21	19	18	20	21
3	Diaphanosoma	0	0	12	10	15	19	28	15	9	15	21	9
4	Alonella	5	4	2	6	10	18	32	13	5	9	10	7
	Total	**9**	**13**	**27**	**44**	**65**	**109**	**137**	**52**	**33**	**42**	**51**	**39**
	Grand Total	**111**	**132**	**159**	**171**	**256**	**305**	**378**	**226**	**165**	**195**	**242**	**286**

Table- 21

Monthly Variation of Zooplankton

Station-A_3

Period : 2001-2002

S.No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	3	4	4	6	8	10	13	2	4	4	3	6
2	Verticella	4	3	5	4	5	5	6	0	0	2	2	3
3	Arcella	2	2	3	4	1	2	5	2	0	0	1	2
4	Euglypha	5	4	8	1	12	6	3	2	0	0	4	5
5	Euglena	14	28	24	26	35	32	15	13	15	17	16	23
	Total	**28**	**41**	**44**	**41**	**61**	**55**	**42**	**19**	**19**	**23**	**26**	**39**
Rotifera													
1	Brachionus	18	13	15	17	31	32	37	11	12	16	24	28
2	Filinia	2	0	2	3	3	4	7	14	10	20	23	28
3	Keretella	0	0	0	0	0	0	14	6	8	10	14	20
4	Testudinella	0	0	0	0	5	10	12	16	20	23	26	35
5	Philodina	1	3	2	0	4	5	10	12	14	18	20	26
6	Asplanchna	3	2	3	2	3	5	6	0	0	0	0	4
	Total	**24**	**18**	**22**	**22**	**46**	**56**	**86**	**59**	**64**	**87**	**107**	**141**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	10	4	5	14	20	22	26	27	14	7	10	12
2	Mesocyclops	0	0	0	0	0	0	0	2	4	6	8	12
3	Diaptomus	2	4	3	2	1	2	2	2	1	1	2	3
4	Eggs & Nauplii	16	20	22	32	36	32	35	16	13	23	18	29
	Total	**28**	**28**	**30**	**48**	**57**	**56**	**63**	**47**	**32**	**37**	**38**	**56**
(b)	**Cladocerans**												
1	Daphnia	2	6	10	14	20	22	29	6	0	0	0	12
2	Ceriodaphnia	0	0	0	10	16	39	40	20	20	16	20	22
3	Diaphanosoma	0	0	10	6	10	15	20	14	6	10	16	7
4	Alonella	3	4	2	5	9	16	30	26	9	9	12	6
	Total	**5**	**10**	**22**	**35**	**55**	**92**	**119**	**66**	**35**	**35**	**48**	**47**
	Grand Total	**85**	**97**	**118**	**146**	**219**	**259**	**310**	**191**	**150**	**182**	**219**	**283**

Table- 22

Monthly Variation of Zooplankton

Station-A_4

Period : 2001-2002

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	4	8	8	9	12	16	6	7	4	6	3	8
2	Verticella	9	7	9	7	10	10	8	0	0	6	8	10
3	Arcella	5	5	6	7	4	5	4	5	0	0	4	3
4	Euglypha	10	12	11	6	15	7	7	6	0	0	9	12
5	Euglena	16	25	30	28	27	29	40	15	12	30	25	30
	Total	**44**	**57**	**64**	**57**	**68**	**67**	**65**	**33**	**16**	**42**	**49**	**63**
Rotifera													
1	Brachionus	18	10	16	22	24	27	31	15	8	20	22	28
2	Filinia	6	0	4	6	10	16	19	17	15	12	23	27
3	Keretella	0	0	0	0	0	0	5	10	14	19	22	26
4	Testudinella	0	0	0	0	10	11	17	20	27	29	32	36
5	Philodina	4	6	6	0	7	13	15	16	10	20	26	32
6	Asplanchna	12	7	11	5	7	11	13	0	0	0	0	6
	Total	**40**	**23**	**37**	**33**	**58**	**78**	**100**	**78**	**74**	**100**	**125**	**155**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	12	6	6	16	22	24	28	28	14	9	10	13
2	Mesocyclops	0	0	0	0	0	0	0	2	4	6	12	15
3	Diaptomus	4	10	15	4	6	9	9	4	4	2	4	8
4	Eggs & Nauplii	15	20	32	36	48	50	56	15	19	27	28	26
	Total	**31**	**36**	**53**	**56**	**76**	**83**	**93**	**49**	**41**	**44**	**54**	**62**
(b)	**Cladocerans**												
1	Daphnia	5	6	20	19	30	32	39	6	0	0	0	4
2	Ceriodaphnia	0	0	0	16	20	56	48	16	19	16	20	7
3	Diaphanosoma	0	0	10	12	20	26	36	16	8	14	20	6
4	Alonella	7	2	4	6	19	19	39	12	7	9	14	7
	Total	**12**	**8**	**34**	**53**	**89**	**133**	**162**	**50**	**34**	**39**	**54**	**24**
	Grand Total	**127**	**124**	**188**	**199**	**291**	**361**	**420**	**210**	**165**	**225**	**282**	**304**

Table- 23

Monthly Variation of Zooplankton

Station-A_1

Period : 2002-2003

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	6	5	6	9	12	14	3	2	1	2	2	5
2	Verticella	6	6	5	4	8	8	6	0	0	1	4	6
3	Arcella	3	4	4	2	2	5	6	2	0	0	1	2
4	Euglypha	5	3	9	1	12	6	4	3	0	0	5	7
5	Euglena	16	18	26	26	24	39	36	13	19	23	25	36
	Total	**36**	**36**	**50**	**42**	**58**	**72**	**55**	**20**	**20**	**26**	**37**	**56**
Rotifera													
1	Brachionus	18	14	19	18	30	24	29	12	13	16	15	22
2	Filinia	4	0	2	6	4	15	17	9	12	22	25	30
3	Keretella	0	0	0	0	0	0	2	6	9	12	18	25
4	Testudinella	0	0	0	0	6	22	26	10	14	26	30	33
5	Philodina	2	4	3	1	5	6	12	10	12	20	23	28
6	Asplanchna	4	3	4	2	3	6	2	0	0	0	0	4
	Total	**28**	**21**	**28**	**27**	**48**	**73**	**88**	**47**	**60**	**96**	**111**	**142**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	12	5	7	12	20	24	36	32	10	9	12	13
2	Mesocyclops	0	0	0	0	0	0	0	4	9	12	12	16
3	Diaptomus	4	7	4	1	4	4	2	2	2	1	1	4
4	Eggs & Nauplii	15	18	25	25	39	40	42	15	15	23	29	26
	Total	**31**	**30**	**36**	**38**	**63**	**68**	**80**	**53**	**36**	**45**	**54**	**59**
(b)	**Cladocerans**												
1	Daphnia	7	7	10	15	26	29	29	2	0	0	0	3
2	Ceriodaphnia	0	0	0	12	15	46	48	10	25	16	20	6
3	Diaphanosoma	0	0	10	10	17	18	26	16	9	14	22	9
4	Alonella	6	2	4	8	12	16	26	12	5	9	12	6
	Total	**13**	**9**	**24**	**45**	**70**	**109**	**129**	**40**	**39**	**39**	**54**	**24**
	Grand Total	**108**	**96**	**138**	**152**	**239**	**322**	**352**	**160**	**155**	**206**	**256**	**281**

Table- 24

Monthly Variation of Zooplankton

Station-A_2 **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	9	12	12	7	9	12	14	6	5	2	4	7
2	Verticella	6	7	9	8	10	10	7	0	0	4	5	6
3	Arcella	3	5	4	7	2	4	8	2	0	0	2	3
4	Euglypha	6	10	10	5	11	7	5	4	0	0	5	7
5	Euglena	15	18	26	29	27	26	32	19	15	18	27	26
	Total	**39**	**52**	**61**	**56**	**59**	**59**	**66**	**31**	**20**	**24**	**43**	**49**
Rotifera													
1	Brachionus	18	17	12	19	22	26	36	12	12	18	22	36
2	Filinia	6	0	7	5	7	5	19	9	6	21	24	30
3	Keretella	0	0	0	0	0	0	8	14	19	22	26	39
4	Testudinella	0	0	0	0	9	15	20	22	26	28	34	39
5	Philodina	4	6	9	0	6	8	13	15	13	20	23	30
6	Asplanchna	6	5	10	5	7	8	9	0	0	0	0	5
	Total	**34**	**28**	**38**	**29**	**51**	**62**	**105**	**72**	**76**	**109**	**129**	**179**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	14	6	6	15	26	28	30	32	16	10	14	14
2	Mesocyclops	0	0	0	0	0	9	0	6	10	13	15	18
3	Diaptomus	50	10	7	2	5	6	2	5	3	2	2	7
4	Eggs & Nauplii	12	19	23	32	39	42	42	14	15	25	2	26
	Total	**76**	**35**	**36**	**49**	**70**	**85**	**74**	**57**	**44**	**50**	**33**	**65**
(b)	**Cladocerans**												
1	Daphnia	6	9	14	17	26	28	10	4	0	0	0	4
2	Ceriodaphnia	0	0	0	14	18	40	46	15	14	20	16	12
3	Diaphanosoma	0	0	16	16	14	16	22	15	9	10	10	9
4	Alonella	5	6	4	8	10	16	23	16	5	4	10	6
	Total	**11**	**15**	**34**	**55**	**68**	**100**	**101**	**50**	**28**	**34**	**36**	**31**
	Grand Total	**160**	**130**	**169**	**189**	**248**	**306**	**346**	**210**	**168**	**217**	**241**	**324**

Table- 25

Monthly Variation of Zooplankton

Station-A_3 **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	4	5	6	7	8	10	14	2	5	3	4	7
2	Verticella	5	3	4	5	6	6	7	0	0	3	3	4
3	Arcella	3	3	4	4	2	4	6	2	0	0	3	4
4	Euglypha	6	5	9	1	10	7	6	4	0	0	5	6
5	Euglena	15	19	25	26	24	29	33	12	14	17	28	28
	Total	**33**	**35**	**48**	**43**	**50**	**56**	**66**	**20**	**19**	**23**	**43**	**49**
Rotifera													
1	Brachionus	2	4	6	9	12	12	25	15	14	16	29	29
2	Filinia	2	0	4	5	5	4	8	14	10	20	21	18
3	Keretella	0	0	0	0	0	0	5	6	8	12	16	20
4	Testudinella	0	0	0	0	6	12	12	17	20	24	27	20
5	Philodina	2	4	2	0	5	5	10	12	13	18	21	27
6	Asplanchna	4	2	4	3	3	6	6	0	0	0	0	4
	Total	**10**	**10**	**16**	**17**	**31**	**39**	**66**	**64**	**65**	**90**	**114**	**118**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	14	6	6	16	20	27	29	30	30	12	10	12
2	Mesocyclops	0	0	0	0	0	0	0	3	5	6	8	14
3	Diaptomus	3	4	6	2	1	4	4	2	1	1	2	3
4	Eggs & Nauplii	12	16	28	30	31	40	42	14	13	22	20	22
	Total	**29**	**26**	**40**	**48**	**52**	**71**	**75**	**49**	**49**	**41**	**40**	**51**
(b)	**Cladocerans**												
1	Daphnia	6	10	16	17	26	28	32	5	0	0	0	3
2	Ceriodaphnia	0	0	0	12	16	30	32	20	21	20	14	20
3	Diaphanosoma	0	0	12	12	14	16	22	10	9	4	4	2
4	Alonella	5	7	8	8	10	17	16	13	4	6	3	2
	Total	**11**	**17**	**36**	**49**	**66**	**91**	**102**	**48**	**34**	**30**	**21**	**27**
	Grand Total	**83**	**88**	**140**	**157**	**199**	**257**	**309**	**181**	**167**	**184**	**218**	**245**

Table- 26

Monthly Variation of Zooplankton

Station-A_4 **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	4	8	8	9	12	16	6	7	4	6	3	8
2	Verticella	9	7	9	7	10	10	8	0	0	6	8	10
3	Arcella	5	5	6	7	4	5	4	5	0	0	4	4
4	Euglypha	10	12	11	6	15	7	7	6	0	0	9	12
5	Euglena	16	14	23	26	26	25	34	13	15	26	28	29
	Total	**44**	**46**	**57**	**55**	**67**	**63**	**59**	**31**	**19**	**38**	**52**	**63**
Rotifera													
1	Brachionus	6	10	16	22	24	27	31	15	20	28	22	28
2	Filinia	6	0	4	6	10	6	9	12	15	16	23	26
3	Keretella	0	0	0	0	0	0	5	10	14	19	22	27
4	Testudinella	0	0	0	0	10	11	17	20	27	29	32	36
5	Philodina	4	6	6	0	7	13	15	16	10	20	26	30
6	Asplanchna	12	7	11	5	7	11	13	0	0	0	0	7
	Total	**28**	**23**	**37**	**33**	**58**	**68**	**90**	**73**	**86**	**112**	**125**	**154**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	14	6	6	18	21	28	30	33	34	14	14	13
2	Mesocyclops	0	0	0	0	0	0	0	5	6	6	8	16
3	Diaptomus	5	5	8	3	2	3	5	3	2	2	1	2
4	Eggs & Nauplii	14	18	28	32	34	43	42	13	10	22	20	26
	Total	**33**	**29**	**42**	**53**	**57**	**74**	**77**	**54**	**52**	**44**	**43**	**57**
(b)	**Cladocerans**												
1	Daphnia	8	12	18	19	28	28	26	8	0	0	0	6
2	Ceriodaphnia	0	0	0	14	18	32	32	12	15	26	18	22
3	Diaphanosoma	0	0	12	14	16	18	24	12	9	6	4	2
4	Alonella	6	9	10	12	14	18	20	14	6	5	3	2
	Total	**14**	**21**	**40**	**59**	**76**	**96**	**102**	**46**	**30**	**37**	**25**	**32**
	Grand Total	**119**	**119**	**176**	**200**	**258**	**301**	**328**	**204**	**187**	**231**	**245**	**306**

Table-27

Seasnal Variation of Chemical Factors of Vijay Sagar Lake Soil

Period 2001-2002

Months	pH	Phosphorus	Potassium	Nitrogen	Season
November	8.5	H	M	VL	Winter
December	7.8	H	M	M	
January	8.6	MH	MH	H	
February	8.4	MH	H	H	
March	8.0	H	H	H	Summer
April	8.3	L	H	H	
May	8.6	M	M	H	
June	8.2	M	M	H	
July	8.0	H	MH	M	Rainy
August	8.1	H	L	VL	
September	8.0	H	M	VL	
October	8.2	MH	MH	H	

MH. = Medium High,
M = Medium
H. High,
VL = Very Low
L=Low,

Table-28

Seasnal Variation of Chemical Factors of Vijay Sagar Lake Soil

Period 2002-2003

Months	pH	Phosphorus	Potassium	Nitrogen	Season
November	8.00	H	M	VL	Winter
December	7.50	MH	MH	L	
January	8.20	MH	MH	M	
February	8.60	MH	H	H	
March	8.00	H	H	H	Summer
April	8.40	L	M	H	
May	8.70	M	H	H	
June	8.10	M	M	MH	
July	8.00	M	M	M	Rainy
August	8.00	H	MH	VL	
September	8.30	MH	L	VL	
October	8.20	MH	M	M	

MH. = Medium High,
M = Medium
H. High,
VL = Very Low
L = Low,

DISCUSSION

DISCUSSION

Vijay sagar lake is a remarkable fresh water ecosystem. To study this ecosystem, abiotic and biotic characteristics were considered. The biota are highly affected by the abiotic factors, because these factors change the chemical and physical nature of water. Besides, soil conditions also play an important role in chemical changes of water body. Excess of some factors may limit the productivity of the aquatic biota and also cause eutrophication.

The meteoreological conditions have also direct impact on the aquatic ecosystem. Having in view the above factors Vijay sagar lake was studied for the period of two years (Dec.,2001-Nov., 2003).

Data as regards atmospheric temperature, rainfall, relative humidity, photoperiod are taken and monthly mean is calculated. The affect of the above conditions are as under :

Atmospheric Temperature

Water temperature directely related to atmospheric temperature when the high atmospheric temperature then water temperature also increases and vice versa. Maximum atmospheric temperature was found in the moth of June (41.5^{0}C.) and minimum in January (7^{0}C.). As the atmospheric temperature directly affects the water temperature so enhences the lake water temperature its positive impact on the primary production of lake.

Rain fall

It was high during monsoon period (248.32mm.August) and minimum in winter season (1mm., December). Rain fall increase the turbidity of lake water due to silting and decomposition of organic matters in mansoon period,

whereas turbidity was less in winter seasons due to minimum rains. This factor adversely affects on photosynthetic activity in the lake, which decreases the concentration of dissolved oxygen (D.O.) with the result productivity of water becomes low.

Relative humidity

It is directly related with atmosphenic temperature and rainfall. The relative humidity increases in mansoon period and lower in summer season high relative humidity was due to cloudy weather and rains, which as negative impact on photosynthetic activities and also adversly effect the biology of aquatic biota.

Photoperiod

It is greater in summer season and shorter in winter season. Photosynthesis is directly related to photoperiod, which increase the concentration of oxygen. High photoperiod was due to high intensity of solar radiation.

A. Abiotic factors- These include physical and chemical factors. As regards these the parameters are taken : colour, depth, turbidity, water temperature, hydrogen-ion concentration, total alkalinity, carbonate, bicarbonate, dissolved-oxygen, carbondioxide, chloride, ammonical nitrogen and phosphate.

Colour

The colour of the water in lake mostly remains greensh-green to muddy in many months of the year. The lake water was muddy during the months of monsoon period (July to September) due to rains, which cause silting hence low transparency and high turbidity, inhibiting photosynthesis, resulting in low productivity. The greenish to green colour was due to maximum number of

green algae. This indicates the colour of the water is Stanely reservoir was brown and greenish were observed (Ganapati and Sreenivasan, 1968). The greenish colour of the water was due to the presence of thick algae growth in Temple tank, Devikund (Verma and Shukla, 1968). The present work is in confirmity with the above work.

Depth

Water depth in Vijay sagar lake fluctuated between 4.0 to 15 feet minimum depth of water was measured in the month of June and maximum in the months of July and August due to rains. Lower depth in summer season due to water evaporation in greater extent and lack of rains. Higher depth is suitable for fish fauna.

Turbidity

It is quite important factor in determining potability of water. Turbid water is unsuitable for use. In natural waters organic and inorganic materials contribute turbidity which obstruct light penetration and these affects the photosynthetic activities adversely.

According to Wallen (1951) the natural water turbidities are seldom if ever it is , directly lethal to fish and thus affect the productivity of on aquatic system. Wilson (1959) belives that it obstruct the spawning and growth of fish. Turbidity has been traditionally measured in J.T.U. (Jackson turbidity unit). Currently nephlometeric turbidity units (N.T.U.) are used employing Nephlometer in turbidity estimation. The health limit for turbidity is 5 N.T.U. as recommended by W.H.O. Coagulation floculation, sedimentation and filteration of water is necessary for turbidity removal. Singhal et.al., (1986) have reported the turbidity ranging between is to 67.5 N.T.U. in man made managed ponds of Haryana. Water quality of Amarnath pond and Tikanagar pond of

Rourkela examined by Naik et. al., (1996) and reported turbidity between 18.0 to 62.0 N.T.U. and 13.0 to 47.0 N.T.U. Bhaskar bhadra et. al. (2003) have determined the turbidity in ranges from 1.0 to 5.5 N.T.U. in winter months and maximum value of 69.0 N.T.U. was observed in mansoon period.

In the present study the turbidity of lake water ranged from 12.30 to 70.12 N.T.U. during the first year and 13.86 to 64.65 N.T.U. in the second year of study. The highest value of turbidity 70.12 N.T.U. was recorded at station A_4 in August 2001- 02. The higher trend was observed in monsoon and summer period due to surface run off from adjacent area high phytoplankton density and low level of water. The mean value of turbidity during the study period of 2001- 02 ,29.60 to 32.36 N.T.U. and between 30.81to 31.13 N.T.U.in 2002-03 ranged from different sampling stations. Turbidity showed positive co-relation with total alkalinity during present investigation in A_1 and A_4 sampling stations due to decomposition of organic matter. The observations of the present study are in concurrence with other studies done by singhal et. al. (1986), Naik et. al. (1996) and Bhaskar Bhadra et. al. (2003).

Temperature

It is one of the important among various factors. All life processes are accelerated or slowed down by temperature changes in environment. It influences the solubility of gases and salts in water. The volume as well as density of the water depends upon temperature. Generally water temperature is influenced by atmospheric temperature. Rise in temperature of water positively affects the aquatic biota and may even lead to formation of algal blooms in water. But disease resistance in the fishes decreases with in rise the temperature.

Odum and Wilson (1962) reported that if the transparency of the water

is reduced due to silt which reduces light availability, it would adversely effect the temperature of the water and thus the primary production due to lack of photosynthetic activity.It is an important factors for maintaing biological during entire study it showed insignficant negative co-realtion with all physico-chemical parametres except with pH and total alkalinity.

In the present study Vijay sagar lake temperature ranged from 16.0 to 32.9^{0}C in 2001-02 and between 15.9 to 33.0^{0}C in 2002-03 at different sampling stations. The mean value of temperature during the study period of 2001-02 , 26.10 to 26.9^{0}C and between 25.80 to 27.08^{0}C in 2002-03 ranged from different sampling stations. Highest temperature were recorded during the summer season and lowest in winter season. At stations A_1 and A_4 ihe temperature were high due to high atmospheric temperature, low water level, hot winds, clear atmospheric and great insulution from the sun. At station A_2 the maximum temperature recorded was comparatively lower, mainly due to trees and deepness. But the variations in the water temperature at different stations were very narrow.Temperature showed significant positive correlation with total alkalinity and negative correlation with dissolved-oxygen during investigation.

The seasonal changes in temperature were also found to be the determining factors affecting the chemical and biological characteristics of the water. The dissoloved oxygen contents were generally high in low temperature period of winter. The period of high temperature accompanied by low oxygen was also noticed by Das and Srivastava (1956). Ray et. al.(1966), and Mathew (1975).

According to Allen (1920)Chandler (1944)and Jackson and Meir(1965) temperature is one of the determining factors in the seasonal concentrations of planktonic organisms.Regarding the role of temperature in regulating the

seasonal abundance of different groups of zooplankton, varying statement have been put forward Byars (1960) reported that the temperature had the greatest influence on the productivity of Rotifers. Ganapti and Rao (1954) and Chen (1965) have mentioned that the seasonal variations in the density of Copepods were influenced by temperature. The Rotifers showed preference for lower temperature and were abundant in November, though they were also in good numbers in the month of June due to Considerable quantity of diatoms and blue green algae. The Copepods showed similar pattern, though withstand greater thermal variations and were abundant in September and November during present investigation. Minimum water temperature was recorded in the month of January and February, while Maximum temperature was observed in June and July (Sreenivasan, 1974; Saha and Chaudhary, 1985; Saha and Pandit, 1986 and Singhal et. al. 1986) in almost all the Indian water bodies. In the present study also a similar trend has been observed.

Hydrogen-Ion-Concentration(pH)

pH indicates the intensity of acidity or alkalinity and measures the concentration of hydrogen-ions in water. Acidity or alkalinity depends upon excess of H^+ or OH^- ions and measured in normality. Generally most of the surface waters are alkaline in nature with an average pH range of 7.0 to 8.5.

In the present study lake water showed alkaline nature throughout the study period. The pH of lake water ranged from 7.68 to 8.40 in the year 2001-02 and between 7.80 to 8.20 in 2002-2003 at different sampling stations. The mean value of pH during the study period of 2001-02 varied from 7.98 to 8.18 and in 2002-03 ranged from 8.03 to 8.04 at different sampling stations. The low value of pH was noted in mansoon period which might be a result of increased water volume that brings change in the level of carbonates pH shows direct relationship with total alkalinity.

The desirable limit of pH value for fish culture is prescribed in BIS limit is 6.O to 9.0 and for irrigation use it is 5.5 to 9.0. The pH in mansoon period (July to September) was noticed comparatevely low (Ray et. al., 1966), which was apparently due to the dilution of water (Parmeswrn et. al., 1971), more turbidity and addition of Co_2 in the form of carbonic acid from the rain water (Chakkrabarty et. al., 1959). The higher pH values in the summer month of June were probably due to much concentration of HCo_3 and high decomposition of organic matter. The pH also affects the diurnal and seasonal changes as worked out in the present investigation.

Worthington (1930). Juday et. al.,(1935) and Hutchinson (1957). Ohle (1938) gave the pH limit of 4.8 and 10.8 below or above which, it has harmful effects. Ganpati (1943) reported pH ranging from 7.6 to 7.8 in Madras tanks.

Banerjee (1967) after investigating nearly eighty ponds concluded that pH 6.5 to 7.5 is most suitable for a fish pond, while a pH range of 7.5 to 8.5 is for average production.In the present investigation the pH values ranged between 7.6 to 8.4 and this range is suitable for average fish production.The present is resemble with the work of Banerjee(1967).The pH range of the lake also similar with other studies conducted by Worthington(1930)and Juday et. al.(1935).

The suitability of alkaline nature of water for fish production was also noticed by Alikunti et. al. (1955), Dubey and Verma (1966) and Das and Pathani (1978). The Vijay sagar lake is also alkaline and thus it similar with these studies.

Total Alkalanity

Alkalanity of water is its capacity to neutralize strong acid and is characterised by the presence of hydroxyl-ions capable of combining with

hydrogen-ions. Alkalinity in water is caused by the presence of bicarbonates, Carbonates, Hydroxides and phosphates. Naturally coloured waters also contain humates which also add to the alkalinity of waters.

Information regarding the alkalinity is desirable primarily because of its relationship to the available carbon-di-oxide and because of its use as an indicator of productivity (Wallen, 1955). The decrease in alkalinity due to dilution of water with the advent of rains have been recorded by several workers (Dutta et. al., 1954; Mukerjee and Bhattacharya, 1949; Bamforth, 1958; Tucker op. cit. ; Chakarborty et. al., 1959; Goldman and Wetzel, 1963; Sreenivasan, 1966; Sharma, 1983; Singh, 1983; Singh 1985 and Singh, 1992). The alkalinity which was maximum in the month of June registered a abrupt fall immediately after the monsoon rains due to dilution of water from September onwards, the alkalinity showed an increasing trend. Mechael (op.cit.) and Subba Rao and Govind (op.cit.) have pointed out the increase in alkalinity with the decrease in water level. Khan et. al. (1990) placed the Bachra reservoir as moderately productive on the basis of high alkalinity (95-162ppm.).

In the present study Vijay sagar lake total alkalinity ranged from 143.3 to 214.9ppm in the year 2001-02 and between 142.0 to 211.1 ppm. in 2002-03 at different sampling stations. The mean value of total alkalinity during the study period of 2001-02 160.95 to 176.34ppm. and between 172.50 to 179.50ppm. in 2002-03 this range was found at different sampling stations. Highest total alkalinity contents were recorded during the summer season and lowest in mansoon period. At stations A_1 and A_4 the total alkalinity contents were very high due to reduction of water level and concentration of carbonates alongwith high decomposition of organic matter. At station A_3 the total alkalinity contents were low due to dilution of water and low level of carbon-di-oxide.

pH is directly related with total alkalinity it was found at all the sampling stations. The present findings are in confirmity with the observations made by other researchers, Singh, (1983), Sreenivasan (1966), Khan et. al. (1990) and Singh (1992).

Carbonate

During the process of photosynthesis, Co_2 is removed, thus increasing the carbonates. Wiebe (1930) suggested the pH is controlled by the photo-synthesis and it would follow that pH and carbonates would vary directly. An apparent co-relation was found between pH and Co_3 in the waters of Rogers lake by Lauff (1958).

In the present study lake water showed alkaline nature throughout the study period. The Carbonate of lake water ranged from 6.6 to 19.8ppm. in the year 2001-02 and between 5.7 to 18.9ppm. in 2002-03 at different sampling stations. The mean value of Carbonate during the study period of 2001-02 varied from 12.30 to 13.49 and in 2002-03 ranged from 11.40 to 18.90 at different sampling stations. The low value of Carbonate was noted in mansoon period, which might be a result of water volume increase that brings change in the level of Hydrogen-ion concentration. Highest values of Co_3 alkalinity were recorded in summer season due to higher photosynthetic activity. Same trends have been observed by Gupta (1989) from Gulab sagar. The present observation has shown a significant increase in the Co_3 range in the lake.

Bicarbonate

The bicarbonate content was invariably in appreciable quantity in water bodies and a wide range of fluctuation was noticed indicating hard and alkaline nature of water bodies. In the present study of lake water bicarbonate throughout the study period varied between 132.4 to 196.2ppm. in the year

2001-02 and ranged from 133.4 to 196.2ppm in 2002-03 at different sampling stations. The mean value bicarbonate during the study period of 2001-02 varied from 159.80 to 163.13 and in 2002-03 varied from 159.70 to 190.10 at different sampling stations. The contents of bicarbonate were high in summer season due to addition of animal excreta and free Co_2. Its concentration may be decreased during winter and mansoon period, due to dilution of water, D.O. is increases and Co_2 concentration decreases.

Awadallah (1990) reported horizontal HCo_3 in Aswan reservoir range of 100 to 226ppm, Rao et. al. (1988) reported HCo_3 range of 100 to 226 ppm from this reservoir higher HCo_3 alkalinity values are recorded in the month of June and lower values in the month of December. The present findings are to some extent resumble with the above work. Shreenivasan (1970) reported HCo_3 alkalinity values ranging from 11 to 70ppm. from Aliyar reservoir. Singh and Desai (1980) reported HCo_3 alkalinity values from 4.53 to 46.14mg/l in Rihand reservoir. In Vijay sagar lake HCo_3- values are comperatively higher when compared above reservoirs, which may be due to dissolution of more $CaCo_3$ from the underlying predominantly Calcium stones in the lake bed.

Dissolved Oxygen

It is the most important factor for life. The lake water receives oxygen by absorption from the atmosphere at the surface and by photosynthetic activity of inhabiting chlorophyll bearing organisms. High value of dissolved oxygen during winter season and low DO during summer and rainy season have been observed by many workers (Verma, 1967; Verma and Shukla, 1968; Bhora and Bhargava, 1977, Nayik et. al., 1982; Saha and Chaudhary, 1985; Singhal et. al.

In the present study Vijay sagar lake showed dissolved oxygen range varied between 3.1 to 8.0 ppm. in the year 2001-02 and between 4.2 to

8.6ppm in 2002-03 at different sampling stations. The mean value dissolved oxygen during the study period of 2001-02 varied from 5.75 to 6.39ppm. and in 2002-03 ranged from 6.18 to 6.82ppm. at different sampling stations. D.O. was higher during winter and lower in summer season.

Reduced dissolved oxygen during summer has been attributed to high temperature of water, lower water level and excess of suspended silt (Sreenivasan, 1974). The similar phenomenon was observed in Vijay sagar lake. The photosynthetic activity of the phytoplankton effect the dissolved oxygen values. During rainy season the photosynthesis is retarted due to turbid water and cloudy weather, which results in the absence of bright sunshine, hence, the low values of dissolved oxygen were found in the monsoon period and during summer season depletion of D.O. occurred due to high temperature. At high temperature water has a lesser oxygen holding capacity.

The concentration of D.O. is also effected by the contamination of animal excreta, which is maximum at station 'A_4', where minimum values of dissolved oxygen were recorded. An inverse co-relation was found between D.O. and Co_2. (Table 3 to 10). The phytoplankton showed direct relationship with the Zooplankton. The significant negative co-relation of dissolved oxygen with temperature was observed at almost all sampling stations. Singh Desai (1980) reported D.O. values ranging from 7.43 to 8.20 ppm. from Rihand reservoir. The present findings are in confirmity with the above work.

Carbon-di-oxide

The importance of free carbon-di-oxide for an aquatic environment derives from three factors (1) chemically it acts as buffering agent against rapid shiff in acidity alkalinity state (2) It is the most versatile element which conform neumerous compounds. Both lower and exceptionally higher values

of free carbon-di-oxide are harmful to fishes (Laglar, 1982), carbon-di-oxide in natural waters comes from a number of sources. The important ones are 1) Atmospheric carbon-di-oxide (2) Seeping ground water (3) chemical reaction in water (4) Respiration and (5) Bacterial decomposition in tropholytic zone. In aquatic ecosystem carbon-di-oxide is generally found as (1) Free carbon-di-oxide in solution and carbonic acid (2) combined carbon-di-oxide (3) Aggressive carbon-di-oxide required for maintenance of $CaCo_3$ in water.

In present case free carbon-di-oxide ranged from 8.9 to 19.8ppm in the year 2001-02 and between 8.6 to 19.6ppm. in 2002-03 at different sampling station. The mean value Co_2 during the study period of 2001-02 varied from 13.59 to 13.90ppm. and in 2002-03 ranged from 13.26 to 14.27ppm. at different sampling stations. Highest value was observed in summer season and low value in winter season. High Co_2 concentration was due to the decomposition of organic matter under high temperature and respiration of living organisms, which consumes oxygen and liberate carbon-di-oxide. Thus, Co_2 showed an inverse relationship with dissolved oxygen. The highest concentration of carbon-di-oxide was found at stations A_1 and A_4 due to high decomposition of organic matter as leaves and animal excreta.

Welch (1952) stated that high Co_2 contents appears to be more toxic in the presence of low oxygen contents, and usually Co_2 is liberated during respiration but utilised during photosynthesis. Thus the concentration of Co_2 gas is co-related with amount and nature of biological activity in the water. Hutchinson (1957) explained that the study of carbon-di-oxide is quite important to understand the hydrogen-ion concentration of water. The carbon-di-oxide showed an inverse relationship with carbonates in most of the months of the investigation period as during photosynthesis, carbon-di-oxide is removed from the solution, thus increasing the carbonates while a direct relationship

was found with the biocarbonates, because the carbon-di-oxide forms stable carbonets. Carbon-di-oxide shows insignificant positive co-relation with water temperature in present investigation.

Chloride

The level of chloride is an important consideration in the selection of supplies water for human, industrial and agricultural use considerable increase in chlorides in water may be connected with the pollution from house hold sewage. Human and animal excreta have high quantity of chlorides along with nitrogenous compounds. This quantity averages about 6 to 15ppm. chlorides per person per day. Since chloride is said to be accomponied with faces. Hence increase in its concentration may serve as one of the signals of faecal pollution.

Chlorides are one of the most constant components of water. Their concentration hardly changes, chloride in resonable concentrations are not harmful to human but as concentration above 250ppm., they give a salty taste of water and effect the palatability of water, when physico-chemical and biochemical processes take place in water.

In the present study chloride concentration was found in the range of 16.0 to 50.2ppm. in the year 2001-02 and between 12.4 to 48.4ppm. in 2002-03 at different sampling stations. The mean value chloride during the study period of 2001-02 varied from 29.30 to 31.00ppm. and in 2002-03 varied from 27.40 to 30.0ppm. at different sampling stations. The maximum concentration was found at station A_4 in June 2002, while the minimum concentration of chloride was observed at station A_1 in Agust 2003 due to entrance of plenty of water and dilution effect in rainy season. The increasing trend was found at station A_2 and A_4 due to influence of human interference like mass bathing

activities reduction to water volume and faecal matter.

Sarkar et. al. (1964) pointed out that the chloride were not utilized in plant growth and their presence in large amounts in an indication of pollution in water. According to Verma and Shukla (1970) the maximum chloride is notable during the period of maximum growth of phytoplankton, zooplankton and bottom biota. In Tungabhadra reservoir David (1969) recorded chloride value ranging from 11.9 to 42.1 ppm. A clear relationship between chloride and other physico-chemical factors has been established here, Sahai and Sinha (1969) reported a direct co-relation between chloride and water temperature, nitrate and phosphate concentration. Verma and Shukla (1970) and Singh (op. cit.), Sharma (op.cit.) recorded a similar trend in respect of carbonate, bicarbonates, alkalinity and chloride concentration in ponds and tanks. They further co-related maximum growth of phytoplankton, zooplankton and bottom fauna with chloride. In the present study chloride concentration was directly related with phyto & zooplankton densities.

Ammonical Nitrogen

The most important inorganic nitrogen compounds in water are nitrate and ammonia, both are important sources of nitrogen for aquatic bodies. Certain aerobic bacteria convert ammonia into nitrites and then into nitrates. Nitrogen compounds surve as nutrients for aquatic microorganisms and may be partially responsible for the eutrophication of lakes, ponds etc. Ammonical nitrogen is one of the most important indicator of pollution, which indicates the pollution level of the aquatic body. BIS has not set any standard for ammonical nitrogen, however, a level of 1.2ppm. of free ammonia has been recommended by BIS for fish culture. Ammonia toxicity is not a problem in water with pH below 8.0 and ammonia nitrogen concentration less than 1.0ppm. (Agrawal, 1993).

In the present study Vijay sagar lake ammonical nitrogen throughout

the study period varied between 0.21 to 0.80ppm. in the year 2001-02 and ranged from 0.22 to 0.79ppm. in 2002-03 at different sampling stations. The mean value ammonical nitrogen during the study period of 2001-02 varied from 0.39 to 0.52ppm. and in 2002-03 varied from 0.40 to 0.47ppm. at different sampling stations. The contents of ammonical nitrogen were high in summer season, due to high decomposition of organic matter, excreta leaves and also because of high alkalinity and temperature of the lake water during summers. The summer maxima of ammonia concentration was also observed in May and June (Hutchinson, 1957). Decrease in ammonia concentration was found in Agust due to dilution of organic matter by rain water and later an gradual increase during september, October and November. Hence, in the present study the findings of the above factor resemble with the work of Hutchinson (1957).

Nitrogenous substances are derived in the waters by the decomposition of organic materials and the excreta of the animals. Ganapati (1955) reported the distribution of these compounds varying in different water bodies, which depend upon the catchment area, seasons, amount of pollution and planktonic life. If in any water body the phytoplankton is fairly rich and evenly distributed, it utilise all available nitrogen in the water during photosynthesis and causes the absence of nitrates and nitrites and tracs of ammonical nitrogen (Atkins, 1932-33).

Baruah et. al. (1995) found the ammonica nitrogen in the range of 0.21 to 0.82ppm. in Jhangi river of Assam. Tiwari & Nanda (1999) determined ammonical nitrogen in range varied from 0.10 to 0.70ppm. in river Brahmani. The present data coincide with the above work. Besides strong positive co-relation was marked with phosphate during the investigation. Ganapati (1940-41) reported ammonia concentration between 0.003 to 0.216ppm. in a temple

tank and in 1943 from 0.018 to 0.288 ppm. in a garden pond of south India. During hydrobiological survey of fresh water ponds of U.P. wide range of ammonia concentration from 0.059 to 0.378 ppm. was reported by Alikunhi et. al. (1955) and from 0.0 to 2.5 ppm. by Upadhyaya (1964).

Phosphate

Phosphate is regarded as one of chief nutrients required for plant growth and its excess stimulates growth of aquatic flora. The fresh water receive phosphorus as phosphates during rains by the leaching of chemicals from the catchment area, which also cause eutrophication.

The importance of phosphates in natural water has been stressed by several workers. Sarwan et. al. (1991) reported the phosphate in the range of 0.005 to 0.043ppm. in fresh water pond of Srinagar. The inflow of phosphates, alongwith the rain water from the catchment area, indicates the importance of the surroundings in the economy of small water bodies (Singh, 1958, Woodmansee, 1958; Heron, 1961). Joy et. al. (1990) reported the phosphate in the range of 0.0 to 0.64ppm. excess content was noticed during monsoon period.

In the present study Vijay sagar lake phosphate ranged from 0.20 to 0.66ppm. in the year 2001-02 and between 0.23 to 0.69ppm. in 2002-03 at different sampling stations. The mean value of phosphate during the study period of 2001-02 0.39 to 0.50ppm. and between 0.41 to 0.47 in 2002-03 ranged from different sampling stations. Highest phosphate contents were recorded during the mansoon rains, fairly high in autumn, and lowest in summer. At stations A_3 and A_4 the phosphate contents were very high due to decomposition of organic matter, excreta, plant leaves and agricultural run-off. The phosphate ranges are to some extent resemble with the work of Joy et. al. (1990).

Hora and Pillay (1962 have observed that phosphate concentration of 1 ppm. is required for good growth of plankton. Pomeroy et. al. (1962) have suggested that the net zooplankton may excrete an amount of phosphorus nearly to their phosphate contents and this may constitute a significant fraction of requirement of phytoplankton. In Narragansett Bay, Martini (1968) estimated that during spring, the zooplankton excreted phosphorus more than the requirement for the phytoplankton but there was no resultant increase in the concentration of environmental phosphate. Biological significance of nitrates and phosphates has long been Bhattacharya (1965) and Singh (1992) in India fresh water.

The increase in the concentration of phosphate may be caused by temporary enrichment of surface waters brought by heavy rainfall in the catchment area, release from dead cells and contamination by zooplankton excreta. The concentration may be decreased by absorption in the bottom utilization and by phytoplankton.

Phosphorus, though occur in very small quantities in natural waters has been recognised to be the most critical single factor in the maintenance of lake fertility. The occurrence and abundance of phosphorus depends largely on geochemical conditions, domestic sewage, detergents, agriculture effluents with fertilizers. The higher concentration of phosphorus, is indication of pollution.

Atmospheric Temperature (^{0}C)

2001-2002

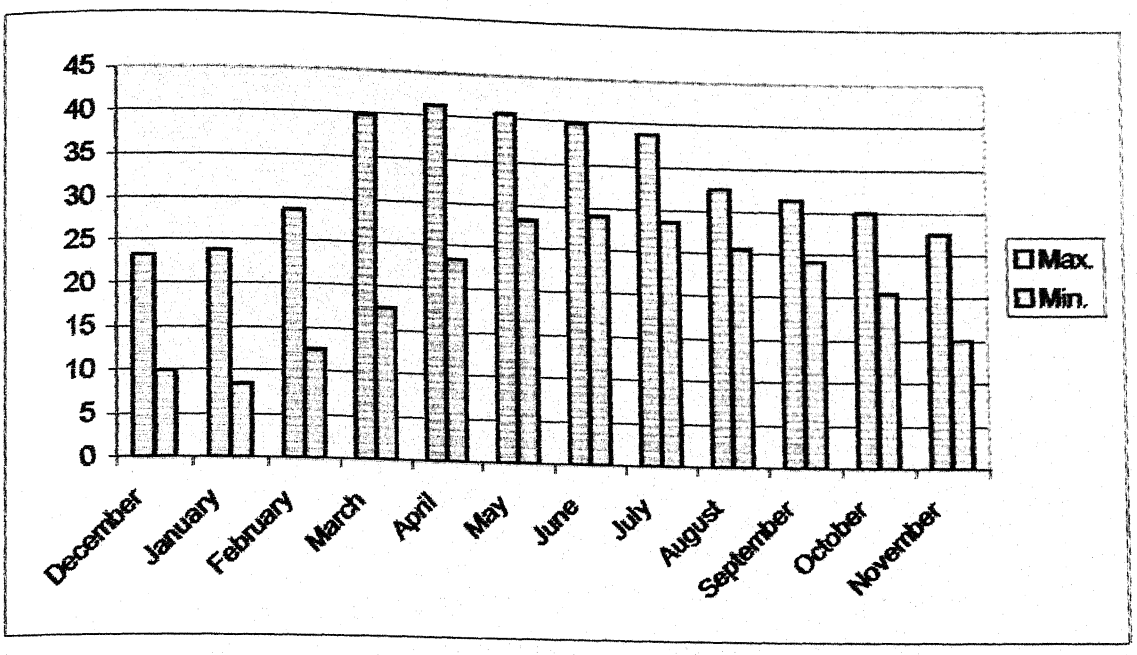


Fig. 2

2002-2003

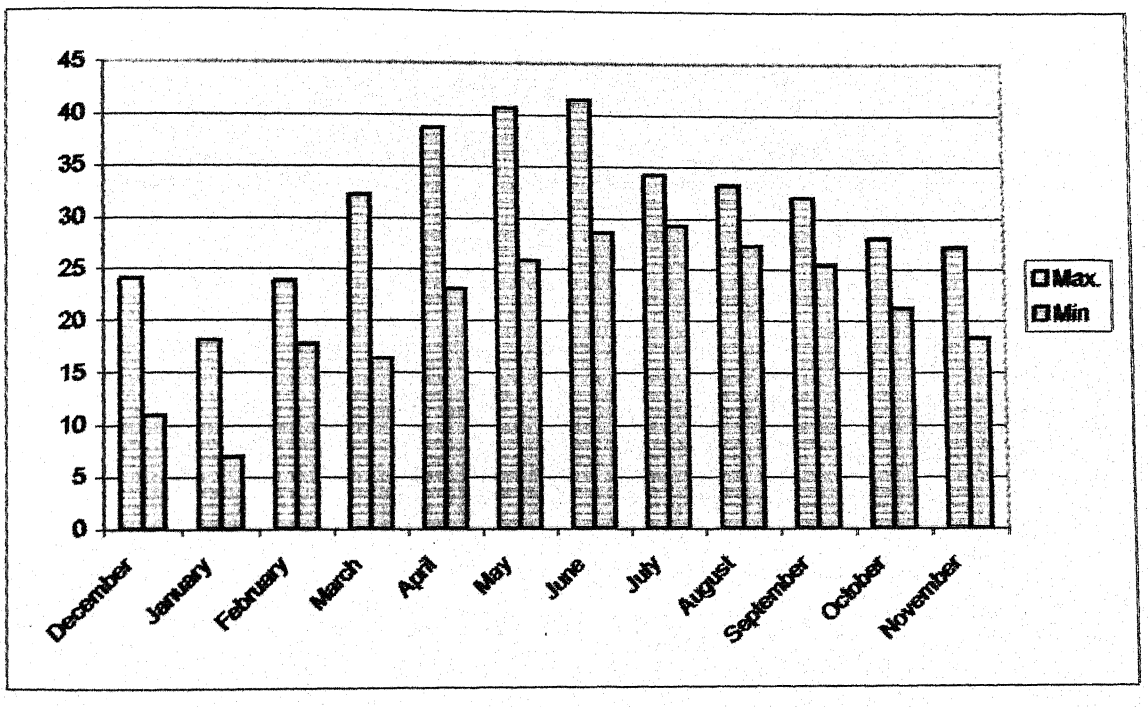


Fig 3

Water Temperature (°c), Tubidity (N.T.U.), & Hydrogen-ion concentration (pH)

2001-2002

STATION-A-1

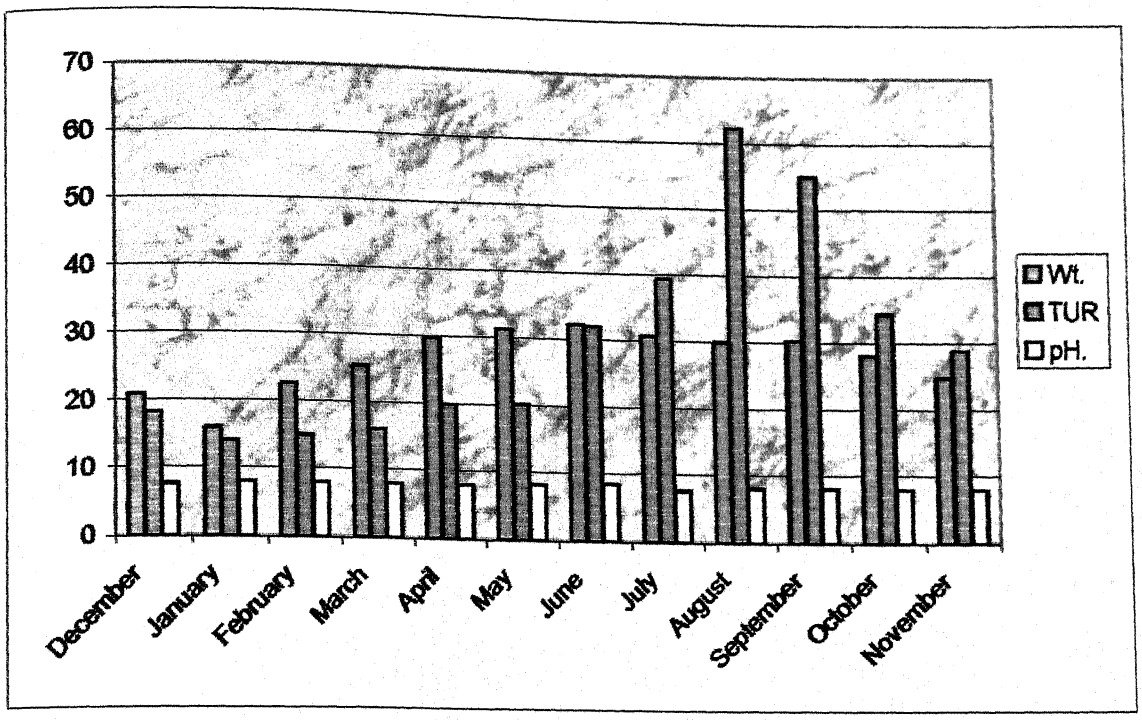


Fig- 4

2001-2002

STATION-A-2

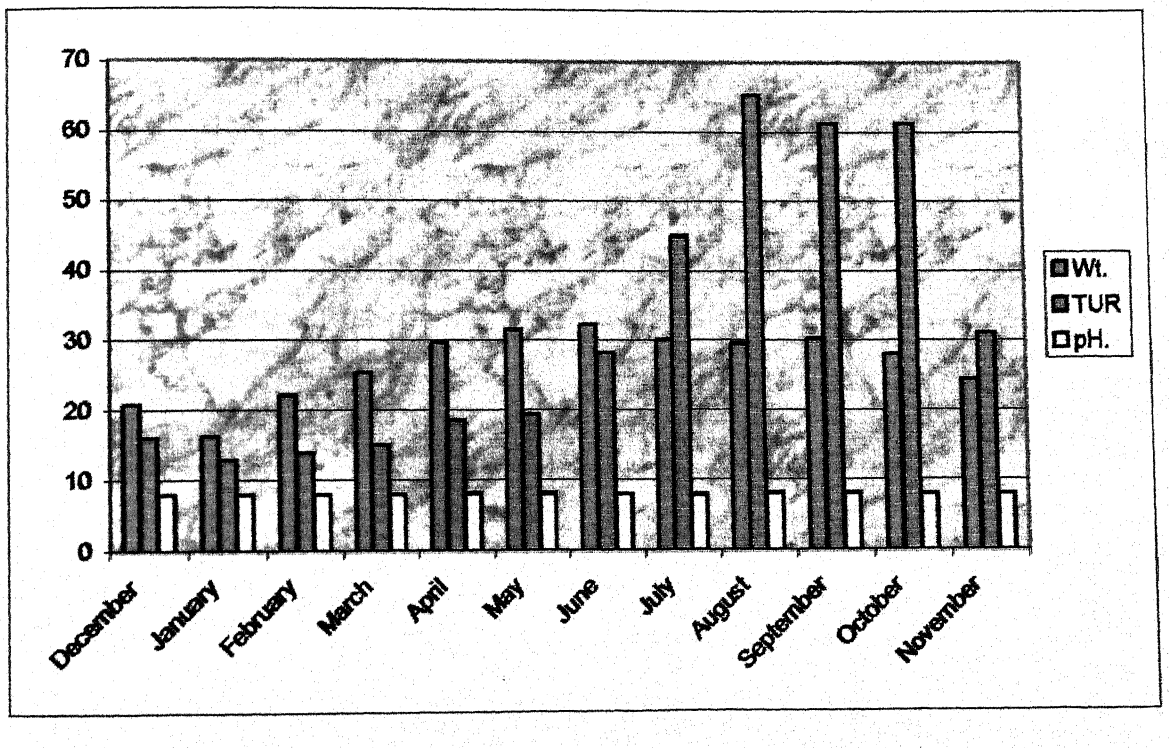


Fig 5

Water Temperature (°c), Tubidity (N.T.U.), & Hydrogen-ion concentration (pH)

2001-2002

STATION-A-3

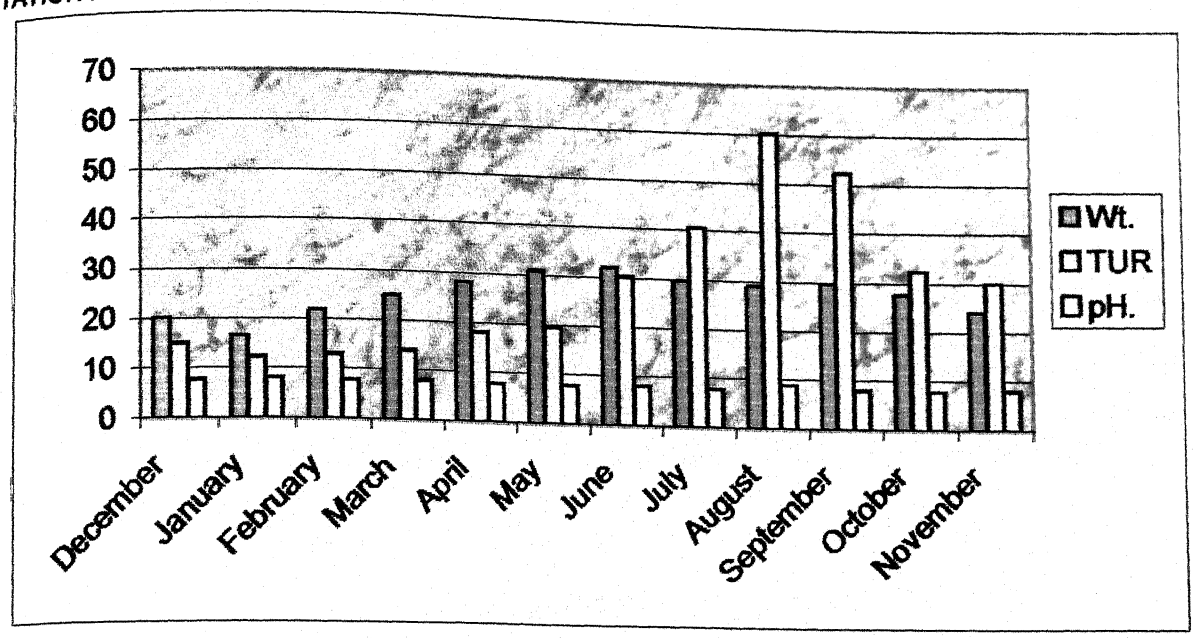


Fig. 6

2001-2002

STATION-A-4

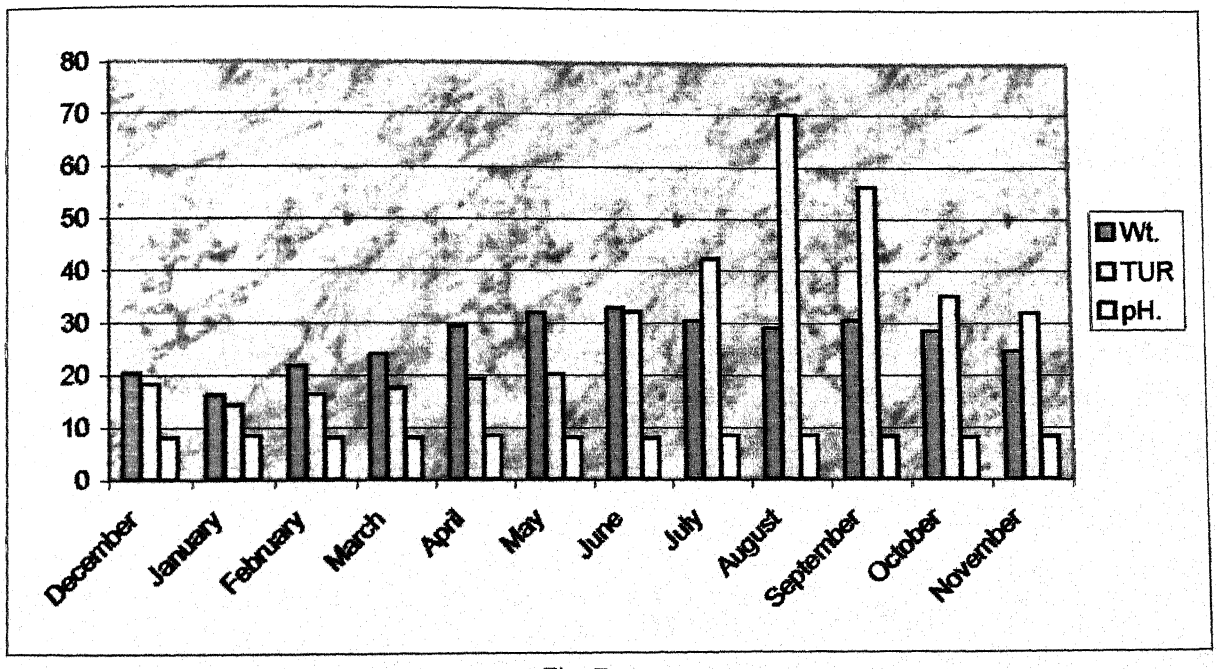


Fig. 7

Water Temperature (°c), Tubidity (N.T.U.), & Hydrogen-ion concentration (pH)

2002-2003

STATION-A-1

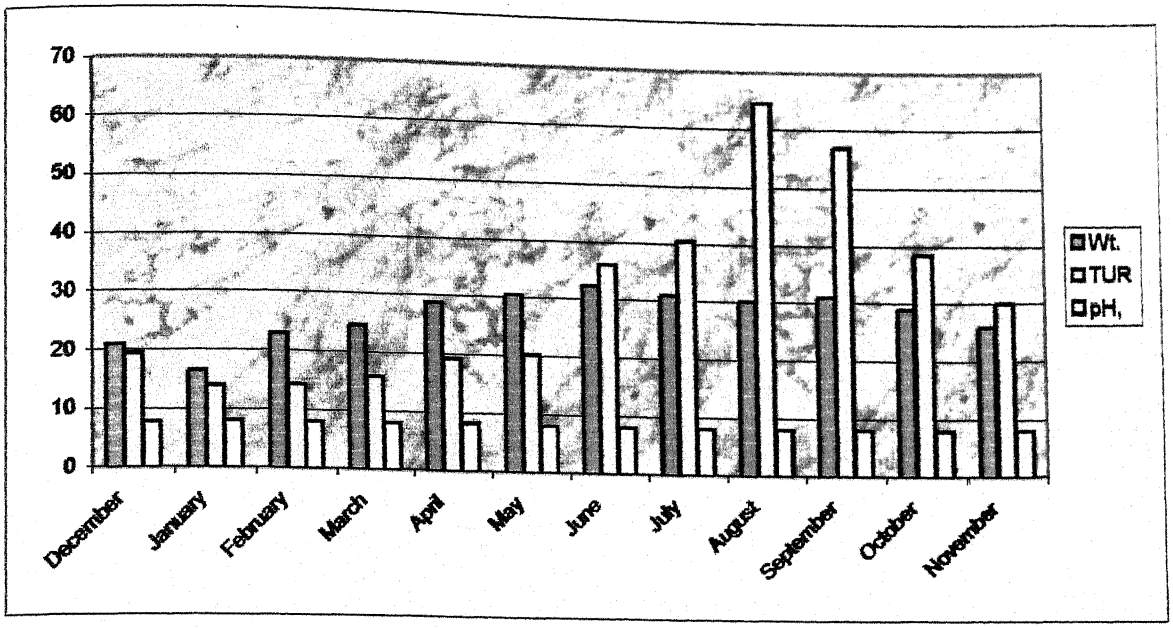


Fig. 8

2002-2003

STATION-A-2

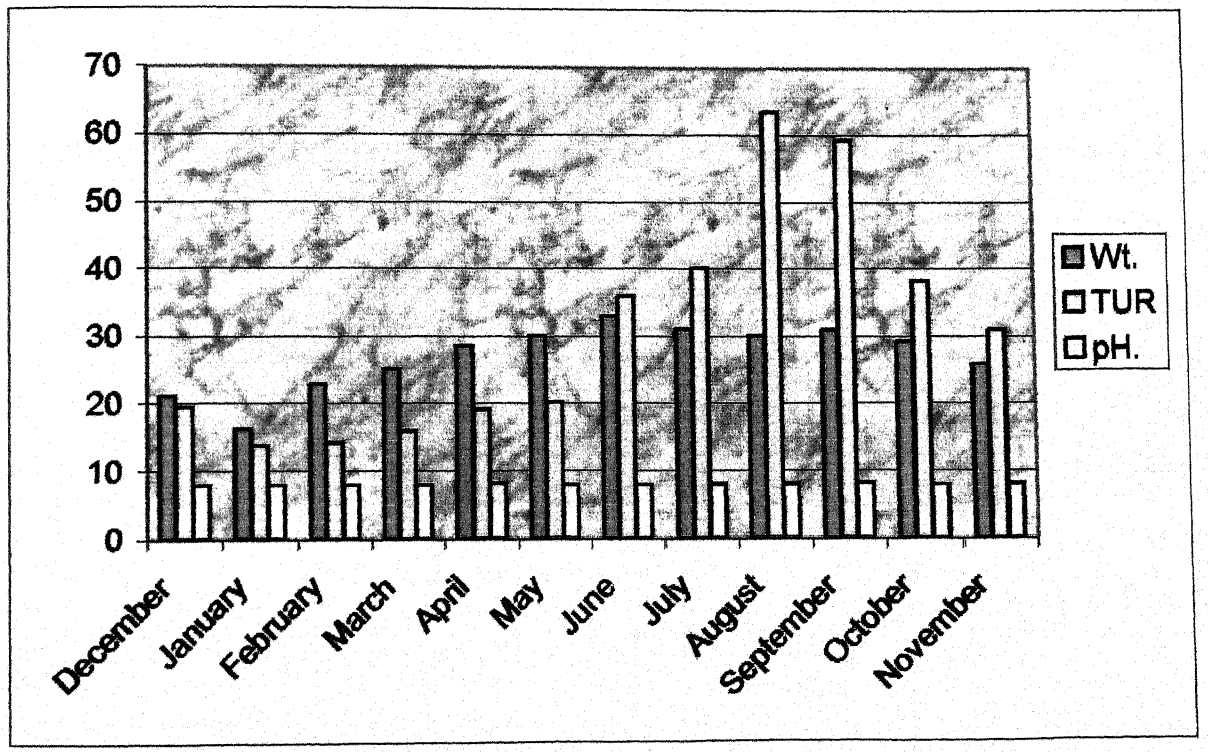


Fig. 9

Water Temperature (°c), Tubidity (N.T.U.), & Hydrogen-ion concentration (pH)

2002-2003

STATION-A-3

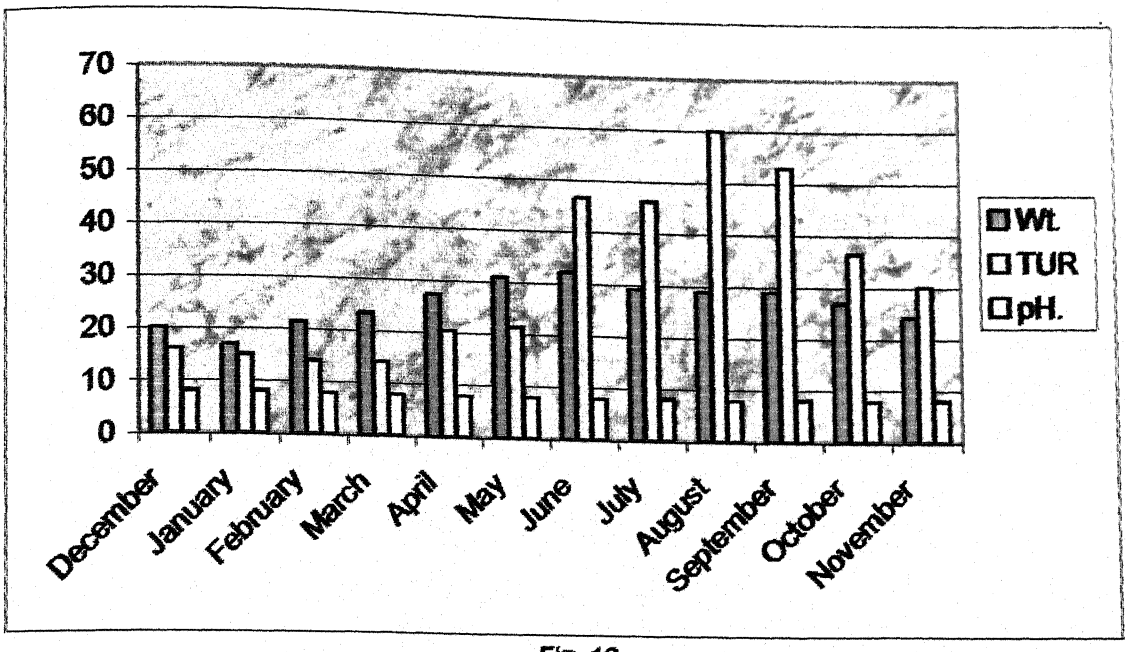


Fig. 10

2002-2003

STATION-A-4

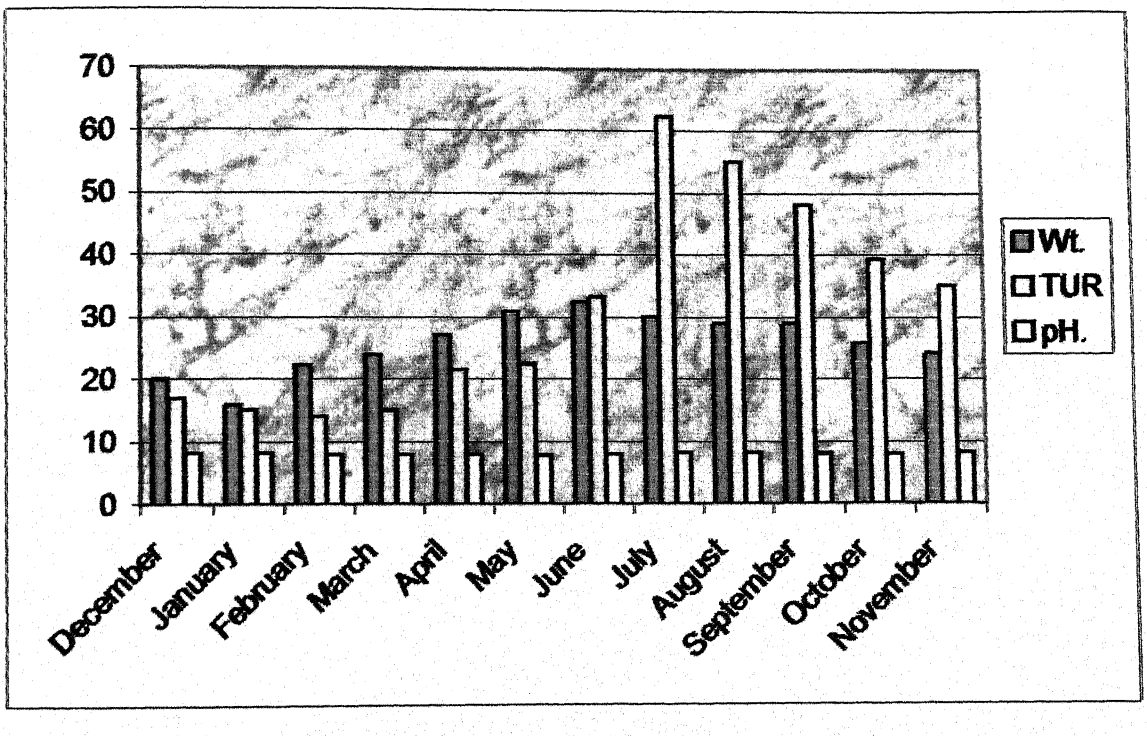


Fig. 11

Carbonate (ppm.) Bicarbonate (ppm.) Total Alkalinity (ppm.) Chloride (ppm.)

STATION-A-1 2001-2002

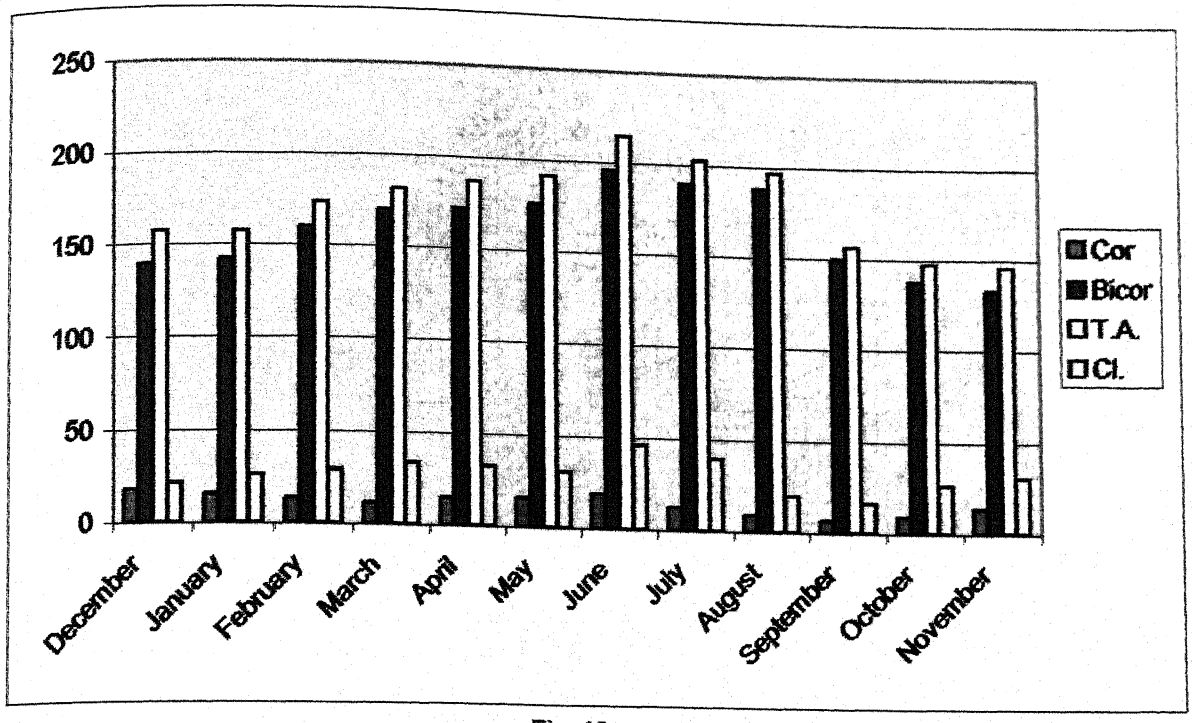


Fig. 12

STATION-A-2

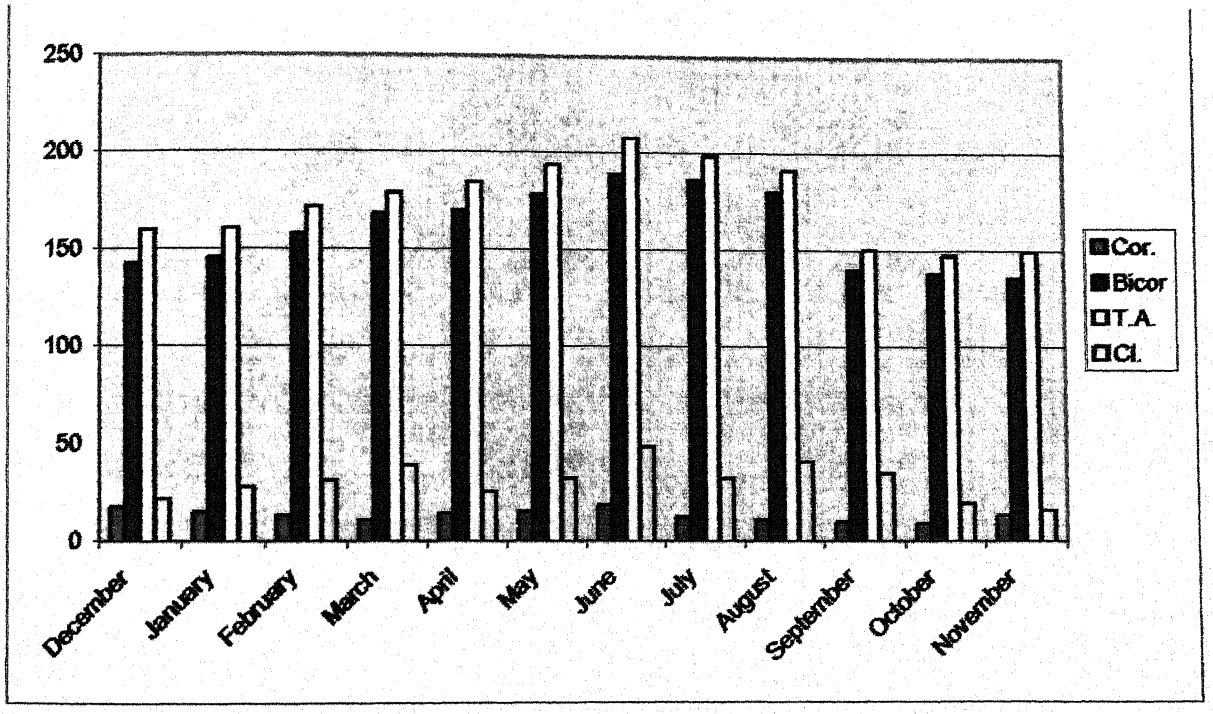


Fig. 13

Carbonate (ppm.) Bicarbonate (ppm.)
Total Alkalinity (ppm.) Chloride (ppm.)

STATION-A-3

2001-2002

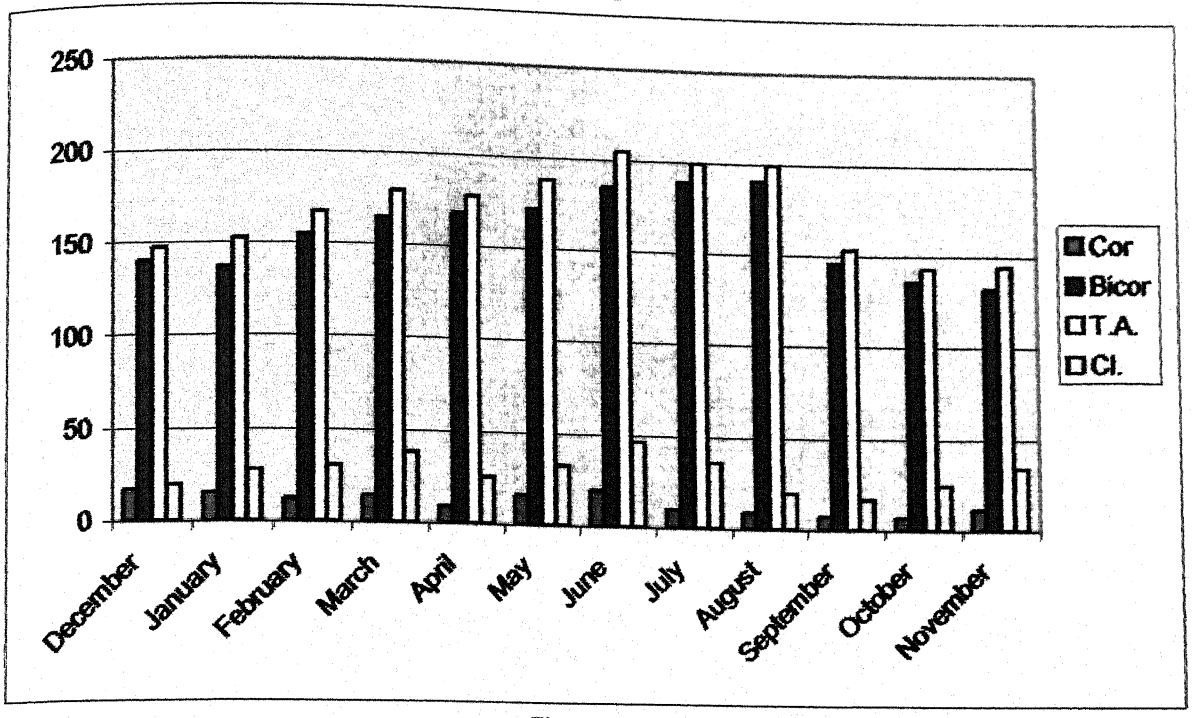


Fig. 14

STATION-A-4

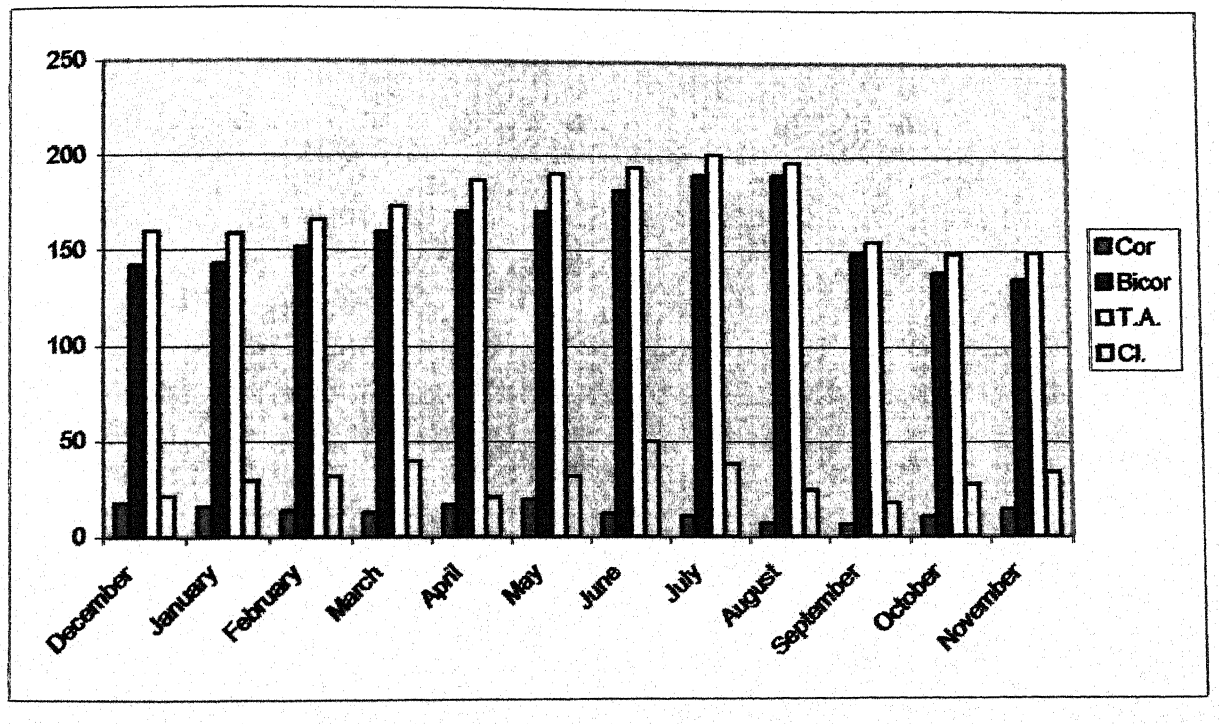


Fig. 15

Carbonate (ppm.) Bicarbonate (ppm.) Total Alkalinity (ppm.) Chloride (ppm.)

STATION-A-1 2002-2003

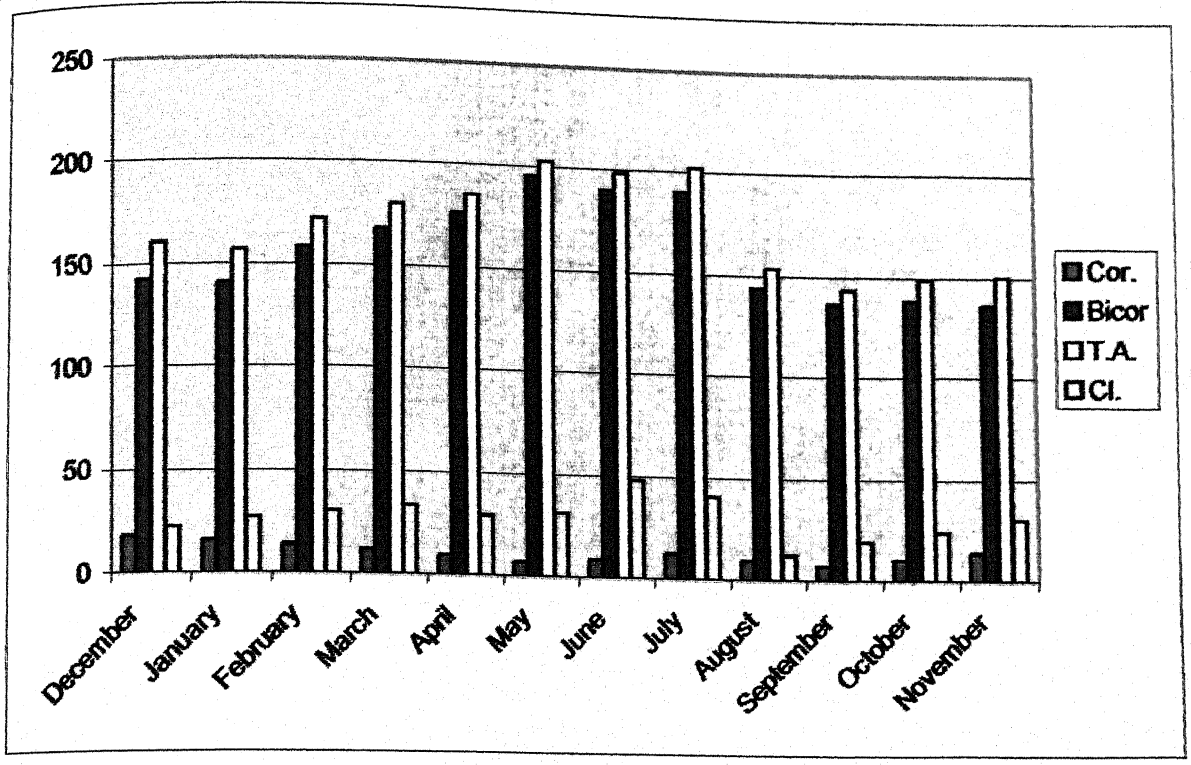


Fig. 16

STATION-A-2

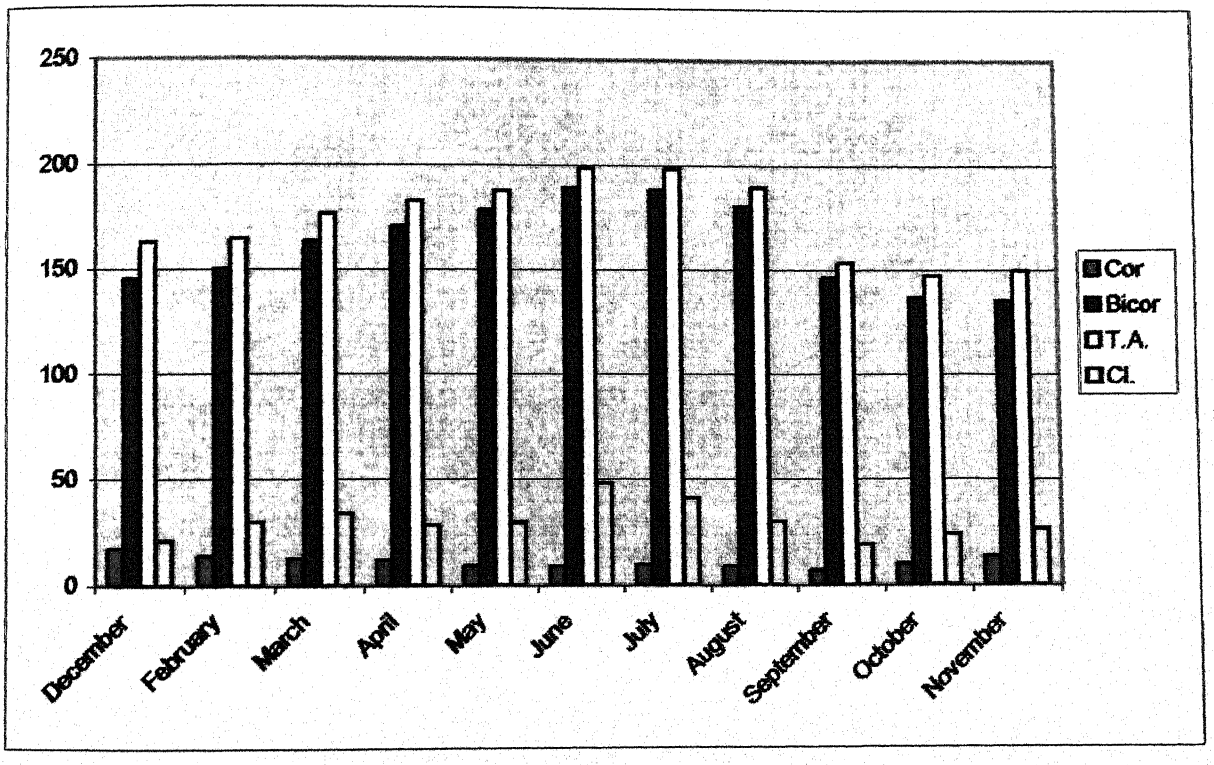


Fig. 17

Carbonate (ppm.) Bicarbonate (ppm.)
Total Alkalinity (ppm.) Chloride (ppm.)

STATION-A-3

2002-2003

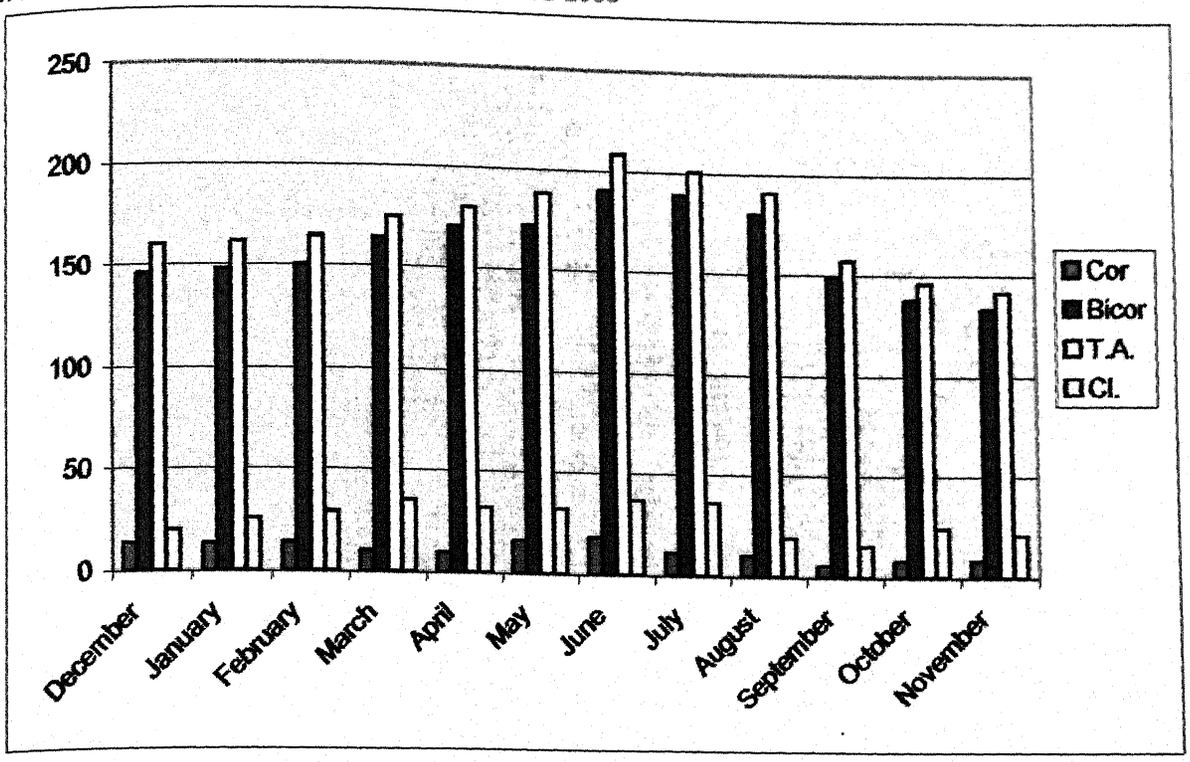


Fig. 18

STATION-A-4

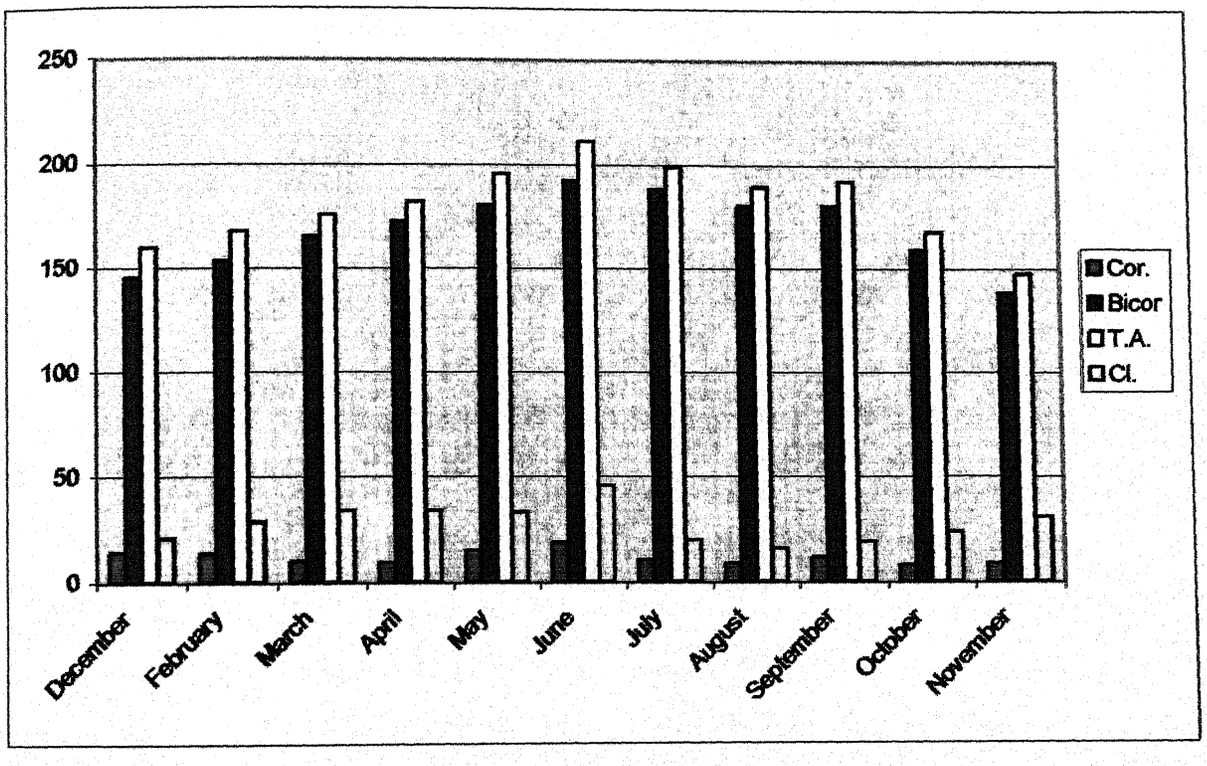


Fig. 19

Ammonical nitrogen (ppm) Phosphate (ppm)
Dessolved oxygen (ppm) Carbon-di-oxid (ppm)

STATION-A-1

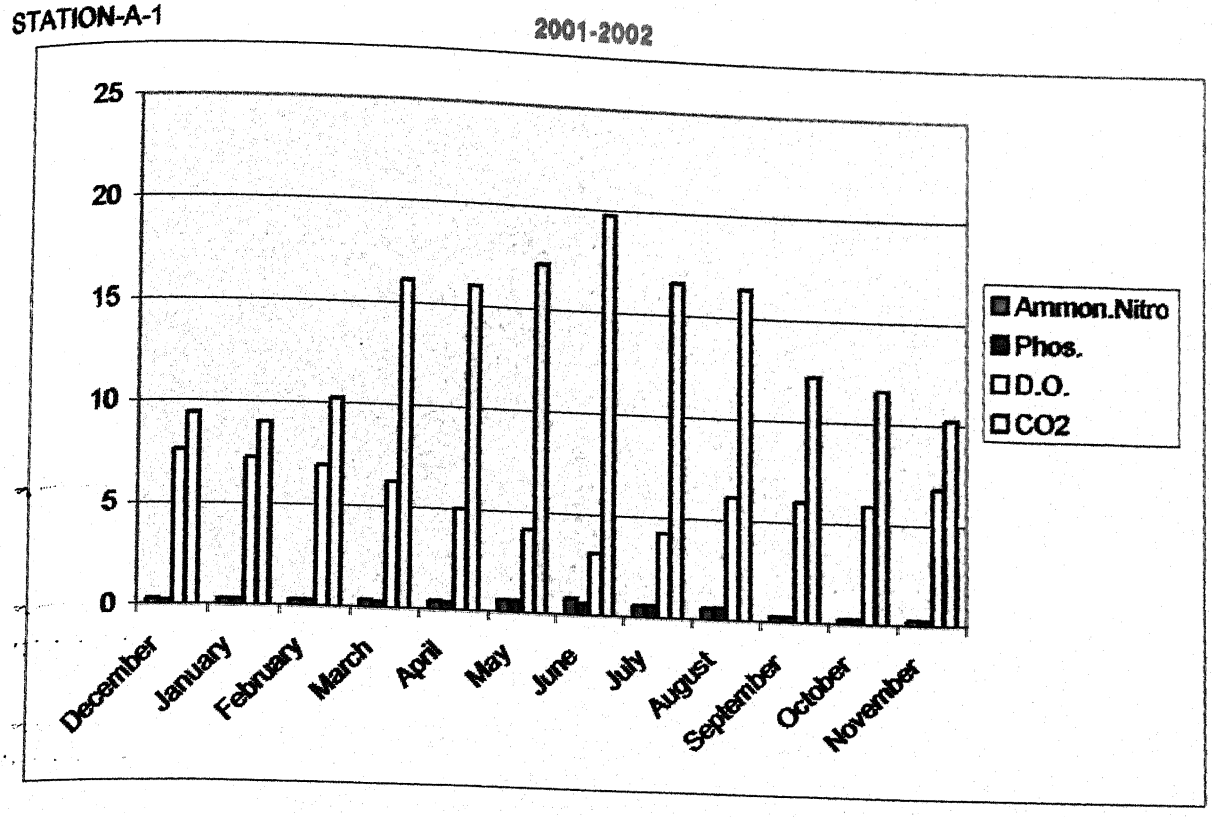


Fig. 20

STATION-A-2

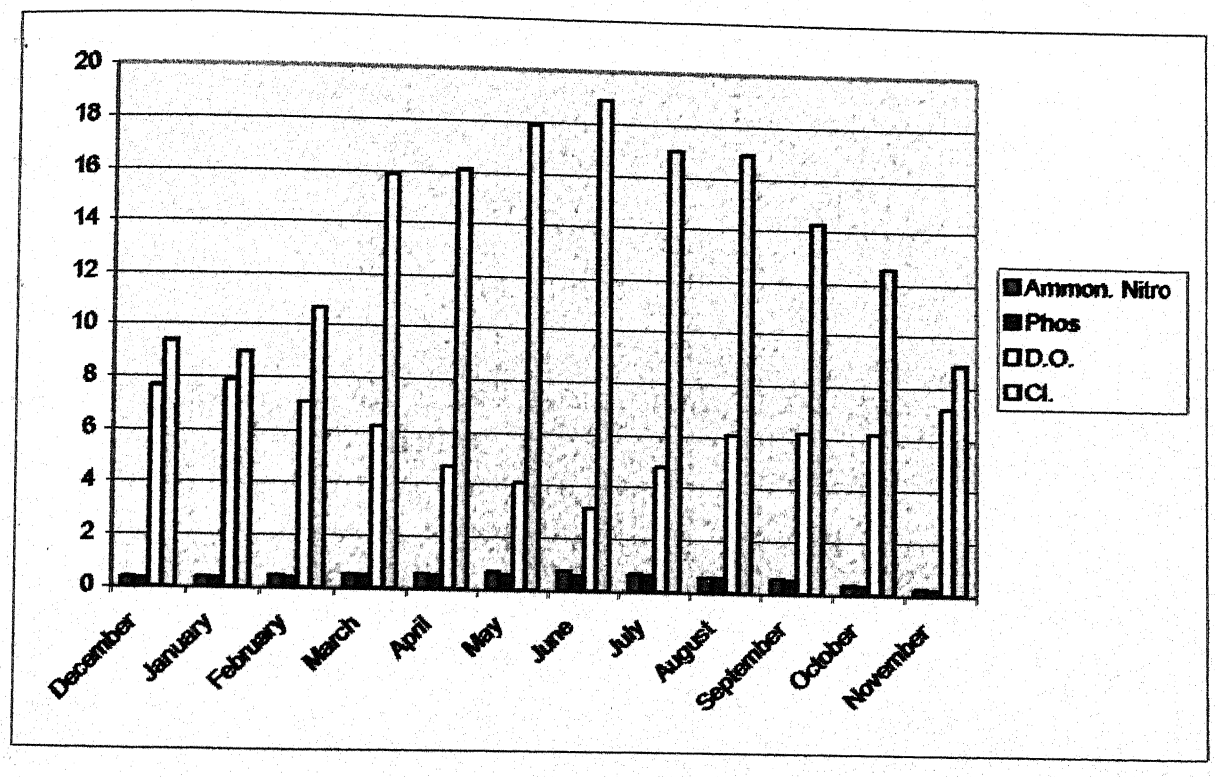


Fig. 21

Ammonical nitrogen (ppm) Phosphate (ppm)
Dessolved oxygen (ppm) Carbon-di-oxid (ppm)

STATION-A-3

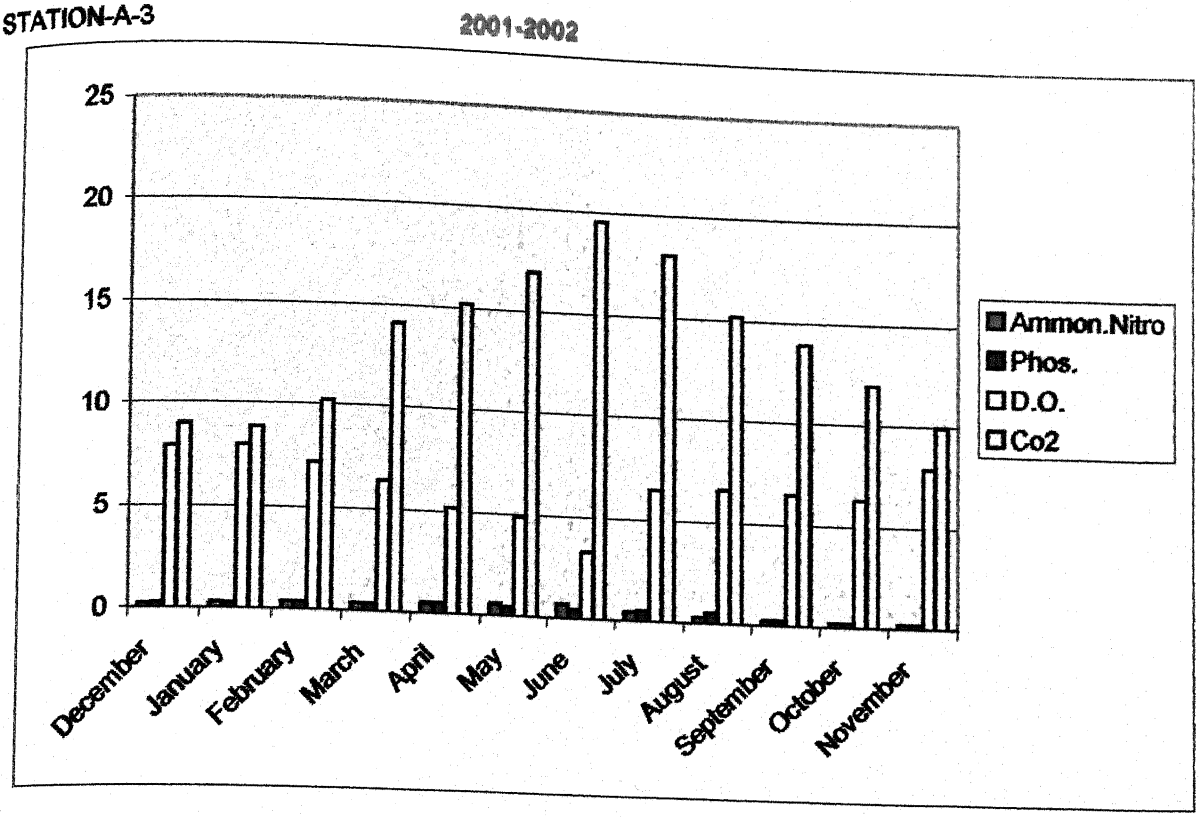


Fig. 22

STATION-A-4

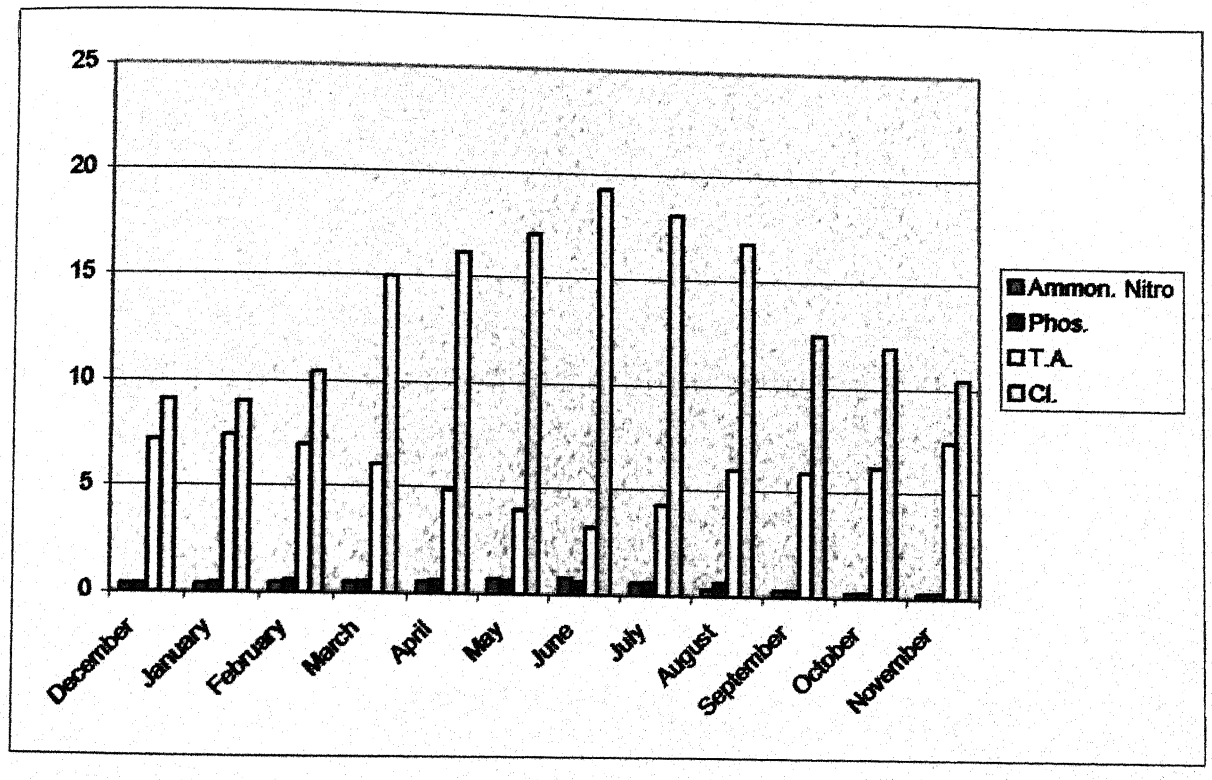


Fig. 23

Ammonical nitrogen (ppm) Phosphate (ppm) Dessolved oxygen (ppm) Carbon-di-oxide(ppm)

STATION-A-1

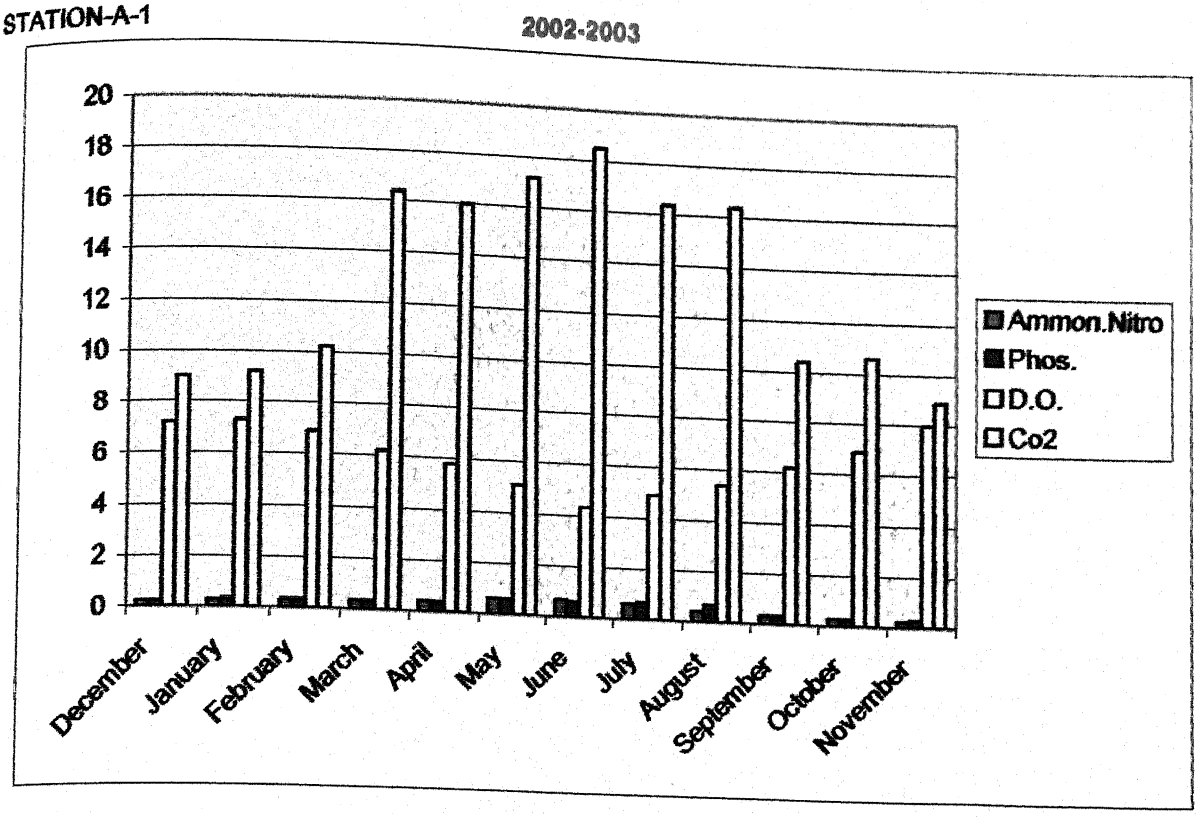


Fig. 24

STATION-A-2

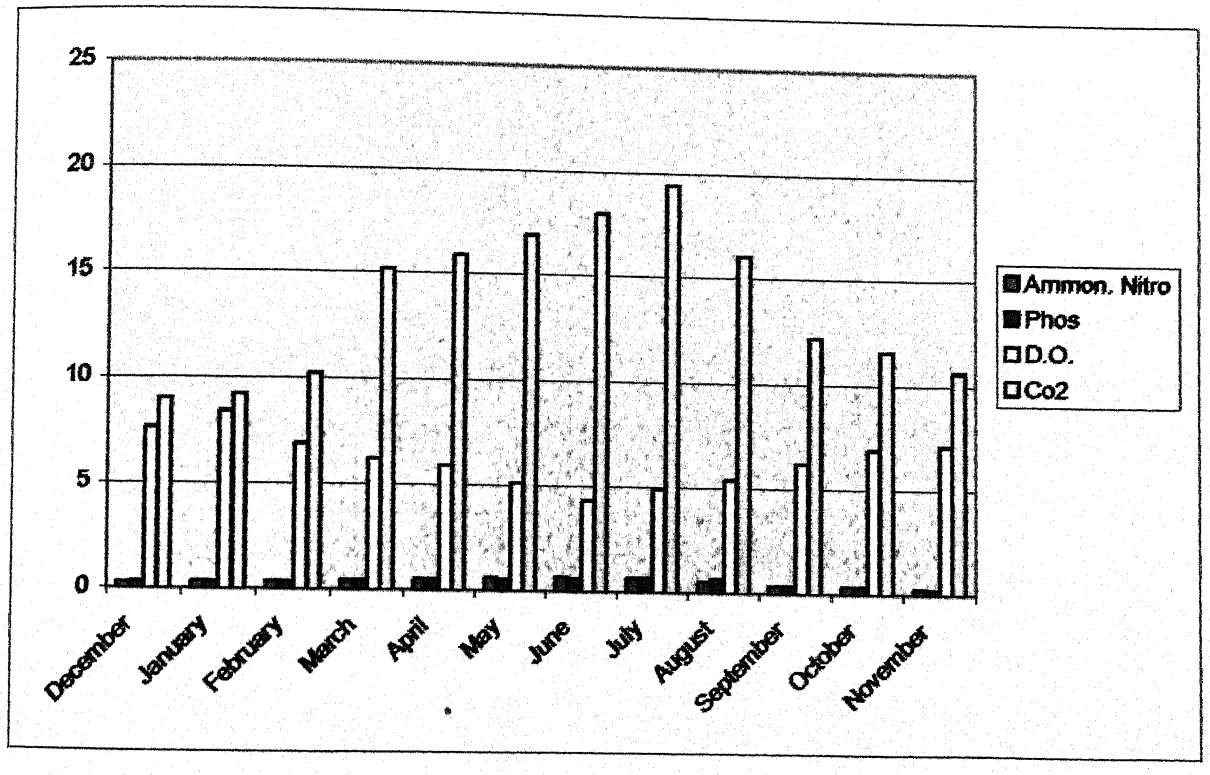


Fig. 25

Ammonical nitrogen (ppm) Phosphate (ppm) Dessolved oxygen (ppm) Carbon-di-oxide (ppm)

STATION-A-3

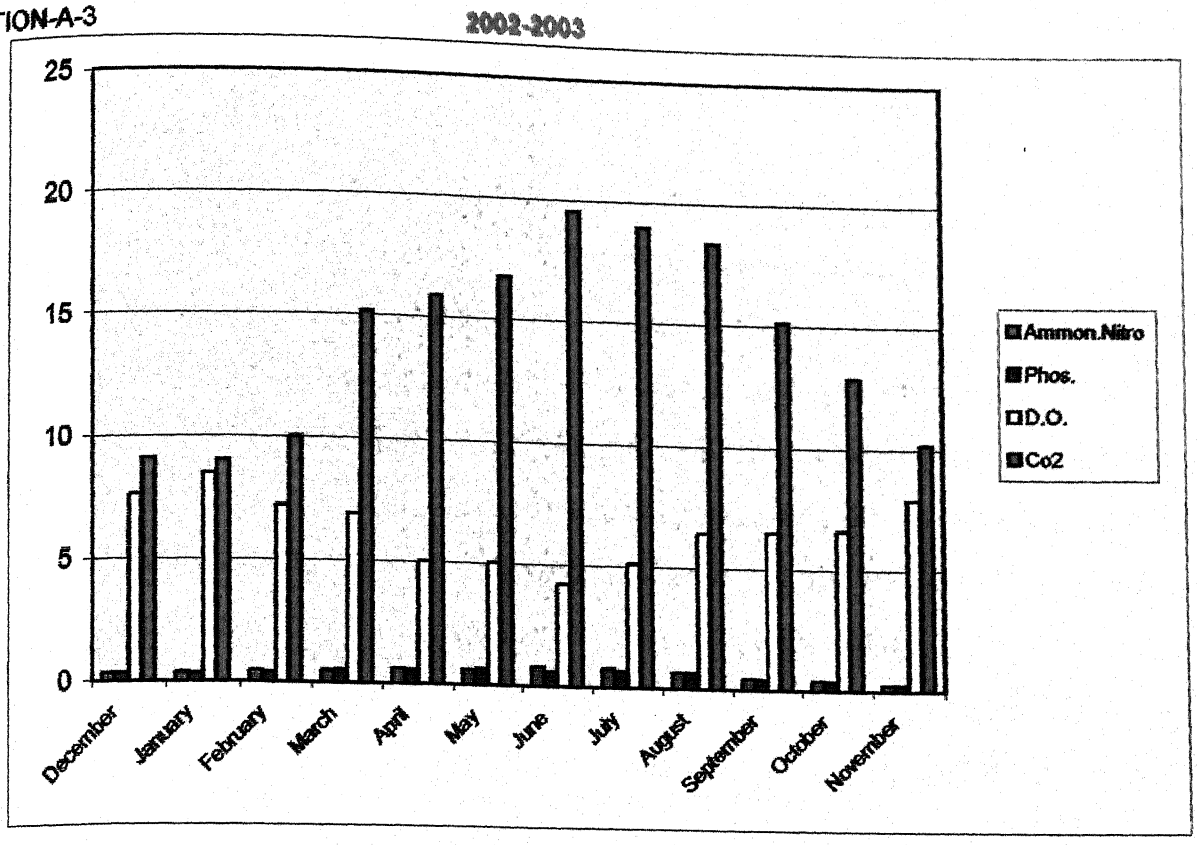


Fig. 26

STATION-A-4

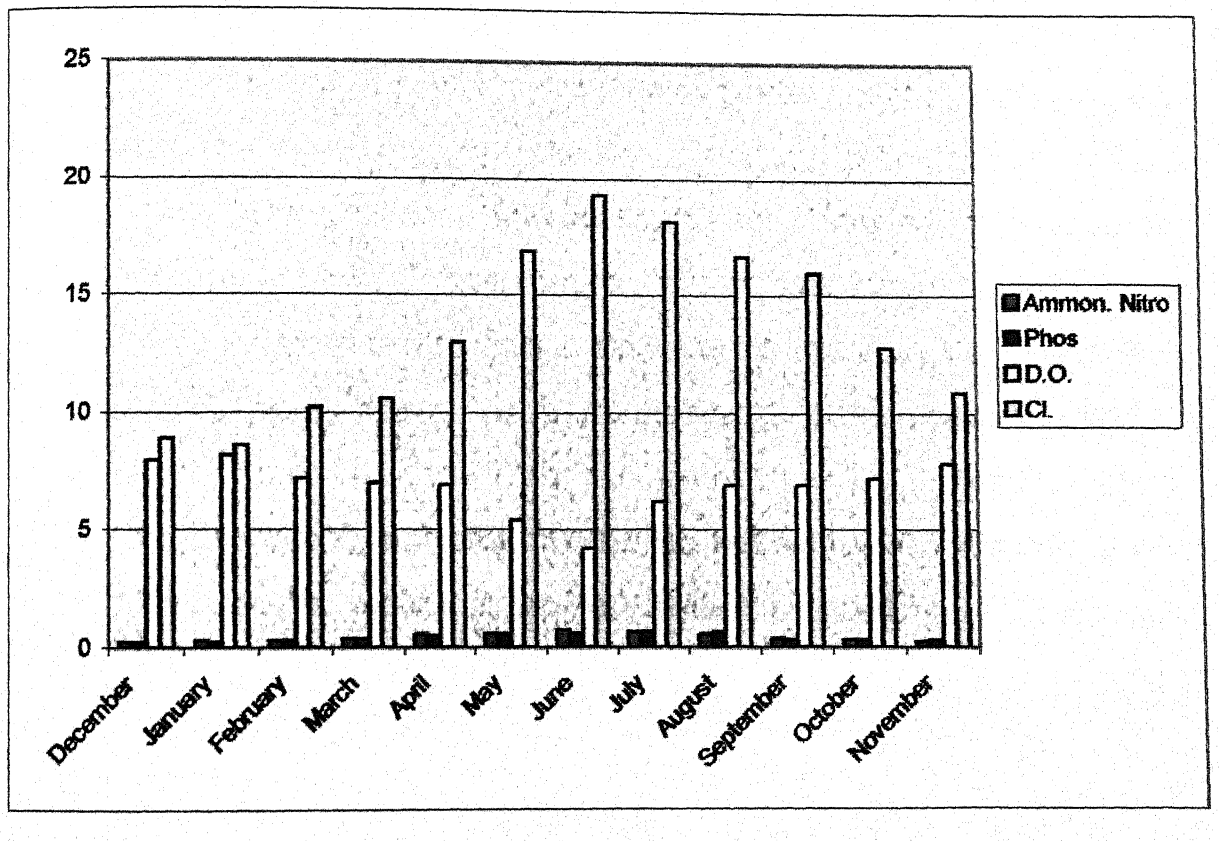


Fig 27

(B) Biotic factors

These include plankton (phytoplankton and zooplankton), aquatic weeds and economically important fishes which are discussed as under :

Phytoplankton- Phytoplakton observed in the present study belongs to the groups chlorophyceae, Cynophyceae and Bacillariophycae. The qualitative and quantitative fluctuations in phytoplankton population depend upon its ecosystem. It was observed that the density of phytoplankton touched peak level in two occasions. The first peak level which was comparatively higher was recorded in April to June and coincided with rise in temperature and decrease in water level. The second peak was found in October and November is the result of accumulation of nutrients after rains. Zafer (1986) also reported similar findings in some south-Indian lakes. During the course of study period, chlorophyceae group was dominant over rest of the phytoplankton population.

Chlorophyceae- Group chlorophyceae varied from 85 org/l. to 465 org/l during the period of present study. Chlorophyceae was abundant during post mansoon period and summer season. Their density was comparatively lesser in rainy season. Which is most dominant in the phytoplankton group during investigation period. Temperature has been considered as an important factor for the regulating the growth and distribution of chlorophyceae. Rao (1955), Zafer (1968), Munawar (1974) and Mehra (1976) observed the maximum growth of chlorophyceae in warmer months of the year. Kant and Kachroo (1977) and Kant and Anand (1978) described a gradual rise in temperature from February onwards; as optimal condition for growth and reproduction of chlorophyceae.

During the present study there was a gradual rise in the population of chlorophyceae from Feburary onwards and touched a peak level in April to June observations of the present study resemble with findings of Kant and Kachroo (1977).

In the present study chlorophyceans yield was maximim during summer season (Tab 11 to 18). The summer maxima can be attributed to:-

(i) Concentration of lake water.

(ii) Maximum mineralization.

(iii) Sufficient light and favourable temperature.

Kant and Anand (1975) observed that chlorophyceans multiplied rapidly in March and poorly represented in rainy season. Verduin (1956); Lund and Talling (1957), Das and Pandey (1979) Pollingher et. al. (1988), and Sarwar and Zutshi (1988) have also reported maximum number of chlorophyceae during summer season. Present work is in confirmity with these workers.

Bacillariophyceae- In Vijay Sagar lake diatoms ranged between 112 to 270org/l in the months of September and May respectivelly (Tab 11 to 18). They were maximum in summer season and minimum during mansoon period.

Vyas (1968) recorded two peaks of diatoms in October and May in the Pichola lake at Udaipur. According to Rao (1977), the seasonal fluctuation of diatoms does not follow any definite pattern, because certain form of diatoms multiply only in summer, and others in winter season. Sharma and Pant (1979) found the summer peak of diatoms in Bhimtal lake. Ab-Hussain and Inason (1988) recorded the peak of diatoms during winter and early summer and associated it with relatively high level of soluble reactive phosphorus, nitrate and with low concentration of reactive silicate. Chang and Rossmann (1988)

recorded diatoms peak in April. In the present study the summer (May and June) peak of diatoms was in accordance with Sharma and Pant (1979).

A direct relation of temperature with diatoms population was recorded by Sharma and Pant (1979), Rao (1979), Pant et.al.(1983), Khan and Ejike (1984). In the present study a direct relationship was found between diatoms population and water temperature, the present work is in concurrence with the above work.

Cyanophyceae-Blue green algae thrive virtually in all aquatic ecosystem because they have an extraordinary functional structural heterogenicity (Carr and Whitton, 1973; Fogg et. al. 1973). Blue green algae benefit not only for their photosynthetic ability but also for their chemotrophic and heterotrophic capabilities too. In the present study Blue green algae were second dominant group among phytoplanktonic community and were seen throughout the year. It varied from 72 org./l. to 389 org./l. (Table 11 to 18). Microcysitis was the most dominant member of blue green algae. Sreenivasan (1970) observed Microcystis bloom throughout the year except in the month of March, in a reservoir at Madras. Inspite of the presence of Microcystis, Ocillatoria appeared as the second dominant genus of Cynophyceae during the period of study. Generally, Microcystis and Oscillatoria were found to be distributed in the whole lake. Shreenivasan (1969) also reported the dominance of group Cynophyceae towards the site of dam in the reservoir.

Tiffany and Britton (1951), Whiteford and Schumacher (1963), Khan et. al. (1978) and Sharma and Pant (1979) associated the dominancy of blue green algae with hot summer months. Rao (1955) recorded the importance of sunshine, while Pearsall (1923) and Ab-Hussein and Inason (1988) gave more importance to high temperature for the development of cynophyceans. A direct relation of blue-green algae with temperature was also noticed by Vyas (1968). Singh ans Swarup (1979) and Unni (1984), Chu and Tiffany (1951

and Rao (1955) pointed out that bright sunshine was more responsible for blue green algae growth, than temperature. Ganapati (1960) considered high temperature, Intensity of illumination, stagnation, high levels of phosphates and ammonical nitrogen, organic matter and magnessium as important factors favouring the formulation of cynophyceae bloom. During investigation was found bright sunshine high temperature, high level of ammonical nitrogen and organic matter, which are more responsible for growth of blue green algae. The observation of the present study are in concurrence with the other studies done by Ganapati (1930), Chu and Tiffany (1951) and Rao (1955).

Blue green algae was able to use bicarbonate more efficiently than other species of algae thereby enabling them to photosynthesize at lower Co_2 concentration and resulting in more carbonates during their abundance (King 1970, Pearl and Vstach, 1982; Shaprio, 1984) due to this fact, a possitive co-relation was found between population of blue green algae and carbonate alkalinity.

According to pearsall (1932) cynophyceae grow rapidly in minimal quantities of nitrate and phosphate, Philipose (1960) and Munwar(1970) reported the utility of nitrate and phosphate in the development of Blue green algae. In the present study a strong positive correlation between blue green algae and phosphate was found. Blue green algae is capable of utilizing first of all ammonical-nitrogen directly. The utilization of nitrogen by blue green algae. An indirect relation with ammonical nitrogen was observed.

Although blue green algae are often found in eutrophic lakes, but they are also known to contribute significantly to phytoplankton population in mesotrophic and oligotrophic lakes (Stockner and Anita, 1986). During the study period it was observed that Vijay sagar lake was moderately productive

and the contribution of blue green algae was in second dominant group of phytoplankton.

Zooplankton

Due to relatively long size span presence throughout the year and their role as grazer of algae and bacteria. Zooplankton particularly of Crustaceans spp. act as intigreator of a variety of physico chemical and biological conditions in lake and their abundance should be a measure of lake productivity (Chapman et.al.1985). Zooplanktonic Community of Vijay sagar lake consisted of Rotifers, Cladocerans, Copepods, Protozoans in the order of dominance. Conspicuous seasonal variatio;n of zooplankton was observed during the study period. The population of Zooplankton ranged from 830 org./l. to 425 org./l. (Table 19 to 26). The maximum number of zooplankton was recorded in the months of May-June and minimum number of zooplankton was recorded in the months of July and August. The summer peak of zooplankton might be due to-

(1) During summer season the temperature was higher which stimulated the reproduction and development of zooplankton.

(2) Higher pH, alkalinity and some other important nutrients during summer season may have directly or indirectly favoured the development of zooplankton population.

(3) Zooplankton are primary consumers and phytoplanktons are known as primary producers. Since phytoplankton serve as food of zooplankton, their abundance during summer season may have enhanced the population of zooplankton in the lake.

The bimodel periodicity of zooplankton over an yearly cycle has been well documented by several workers (Vasisht and Dhir, 1970; Sharma, 1983; Shukla et. al., 1995). In the present study the density of zooplanktonic organ-

isms were highest during May and June, while lowest in July and August months at all sampling stations. The density of zooplankton touched peak level in two occasions, first peak was observed in the months of May and June and second peck was found in months of October and November. The present work in confirmity with the other studies done by Vasisht and Dhir (1970), Sharma (1983) and Shukla et. al. (1995).

Aquatic weeds

The aquatic weeds were found in and nearby of the Vijay sagar lake. Aquatic ecosystem usually support a limited number of vascular plants. Floating species- Lemna sp., Azolla sp. and fixed floating Nelaumbo sp. start to growth from October and make a scum in shore region. They begin to deplete from April onwards. Pistia sp. appeared in July as it came along with the monsoon period. Finally is got settled only in shallow areas. During the present study there was a remarkable increase in the Pistia sp. infestation. Emergent weeds represent only Potamogeton sp.. They were in large numbers and disappear in monsoon period. Marginal plants such as Ipomea sp., Cyperus sp. are also observed in post monsoon period. They die as water recedes from shollow region of lake. Submerged weeds are most dominant among all plant communities and often occupy entire water body except deeper regions making them quite important from fisheries point of view. Ceratophyllum sp. and Hydrilla sp. are the most abundant in entire lake. This density becomes less in monsoon period, while Vallisneria sp. occurs only in shallow region.

Abundance of macrovegetation exhibits relationship with the water current, water level, climatic condition and availability of nutrients. Density of these plants begin to appear with settling of water in post monsoon period when temperature turns to be suitable i.e. below 30°C. Maximum density occurs in October, November, Feburary and March. After the month of March

sudden rise of temperature in Bundelkhand region discourages the growth of these plants similar is the case with nutrients. Major nutrients begin to release in October and November after the settlement of silt and organic material which encourages plants to grow. Higher population of macrovegetation coincids with plankton peaks which represents the periods of eutrophication of the lake. It is worth to be mentioned here that under the current mangement practices lake receives a sizeable number of grass carp seed (Ctenopharyngodon idella). This is an ideal herbivorous fish and voraciously devours Hydrilla sp. Potamogetom sp. and Vallisnaria sp.. Alikuhni and Sukumarn (1964) proved their effeciency for the control of aquatic weeds.

Fishes

Zoological survey of India (1991) has published that about 4000 species of fishes are found in Indian waters, Gunther (1880) found 26 families in India. Day (1885) reported 87 genera in Indian fresh waters. In the present case out these economically important fishes are only 13 species belonging to 11 genera representing 9 families were present in Vijay sagar lake. Heteropneustes fossilis, Clarias batrachus, Xenentodon cancila, Mystus seenghala, Cirrihinus mrigala and Labeo rohita are more abundant in Vijay sagar lake. This may be attributed to muddy bottom of lake and comparatively appropriate exploitation practices. From seasonal fluctuation point of view dissolved oxygen and dessication of lake are important factors. Usually Indian major carps are the versatile and Chanda sp. were present in the upper column of deeper region of lake while minor carps remain in shore areas. Former two species were also abundant in winter when Dissolved Oxygen level was higher while the latters common in summer when vegetation grow more. Cirrhinus mrigala is another fish which is distinctly more abundant in Vijay sagar lake. Ctenopharyngodon idella was found in appear column of deeper region of lake while minor carps remain in shore areas. In the Vijay sagar lake was found average fish produc-

tion, because the inlet and outlet are not properly managed. Besides obviously water circulation and water level are not maintained This lake is also fedup by dense vegetation such as- Nelumbo sp. and Ipomea sp..

Chemical Condition of Soil

The lake bottom has been described by many workers as a laboratory of the lake where nutrients required for imparting productivity to waters are produced by chemical and biochemical processes from raw materials consisting of organic matter and mineral constituents of clay fraction of the soil. The total and available quantity of raw materials are also the requirements of the organisms as to the suitability of conditions of existence and supply of nutrients are essential requirements for a productive lake soil. In this respect major important chemical factors are pH, phosphorus, nitrogen and potassium. Banerjea (1967) has surveyed the soil condition and water quality of a large number of ponds from different soil zones of Eastern and central India in relation to production of fish .The important-chemical characteristics of lake soil are :

pH

The pH of the lake soil depends on various factors.Lake mud are well aerated due to high supply of oxygen, the demposition of organic matter is slow and the products formed of decomposition are hydrogen sulphide,and short chain fatty acids which make the soil alkaline. Unless the soil is naturally buffered, it reduces the rate of bacterial action influencing productivity.The P^H of soil also influences transformation of soluble phosphates and controls the adsorption and release of ions of essential nutrients at soil water interface.In the present study of Vijay sagar lake pH range from 7.8 to 8.7 that is alkaline in nature which is suitable for productivity of water. It inhences higher fish production. The ranges of pH, organic carbon C/N ratio etc. in relation to pond productivity as observed by Benerjea (1967) in a number of fish ponds

from selected regions of India.

Phosphorus- It is the more important for the aquatic productivity. Soil phosphorus shows a definite positive relation with fish production. Banerjea(1967) has grouped pond soils studied by him under four ranges of available phosphorus<30 ppm., 30 to 60ppm., 60 to 120 ppm. and >120 ppm. .Soil phosphorus level < 30 ppm. is considered indicative of poor the range 30 to 60 ppm of average, and the level > 60 ppm of high fish production.In Tamil Nadu Sreenivasn (1976) observed that soils with available phosphorus between 0.5 to 1.0 ppm in the moderate productive group and soil with in the moderate productive group and soil with available phoshorus occurs in soil in both inorganic and organic forms.The inorganic processes of phosphorus fixation depends largely on pH apart from other factors and has been studied by Banerjea and Ghosh (1970) in respect of highly acidic soil of pH <4-5 from Tripura;moderately acidic soils of pH 4.5 to 5.5 from Manipur; slightly acidic soils of pH 6.5 to 7.5 from Assam;near neutral soil of pH 6.5 to 7.5 from Orissa; moderately alkaline soil of pH 7.5 to 8.5 from west Bengal and highly alkaline soil of pH >8.5 from Andhra Pradesh .

In the present study phosphorus range 20 to 42ppm. due to run-off and decomposition of aquatic weeds, which indicate the avarage fish production. Hepher(1958) opinioned that the rapid active phosphate uptake by phytoplankton is not the main cause of the disappearance of the high concentration of phosphorus after fertilization; the principal reasons being adsorption by the bottom mud and chemical process in water resulting in phosphate precipitataion.

Nitrogen

It is the most essential for the fertility of lake. The rise of Nitrogen in soil of fish ponds has been reviewed by Ness (1949) and Hepher (1952).The organic

matter occuring on lake bottom is broken down by a number of micro organisms. The end products of this decomposition among others are Co_2, water and ammonia, while ammonium salts are formed, a number of bacteria found in the soil and water change ammonical nitrogen into nitrates. Nitrates and ammonium salts are reduced to free nitrogen through the agency of denit rifying bacteria, the denitrification depends on dissolved oxyggen in the water accelerating their activity and thereby increasing the release of nitrogen (Helper,1952). Owens and Edwards (1963) have shown that mud, even when the overlying water contain oxygen, reduces nitrates principally to nitrogen or ammonia, Nitrates act as a hydrogen acceptor alternatively to the oxygen. Edwards and Rolley (1965) reported that nitrate reduction by the mud is high when either the O_2 consumption by the mud or the nitrate concentration in the water is high.

In the present study of lake soil nitrogen range from 0.20 to 0.86ppm. which is suitable for average fish production. The soil is the main source of nitrogen supply to the lake through the decomposition of organic matter. The amount of nitrogen available is sufficient for growth of phytoplankton.

Potassium

It is the essential for the growth of aquatic weeds and algae. Under low potassium conditions grow and photosynthesis of algae and aquatic weeds are poor and respiration is higher. No seasonal variation was observed for potassium content of surface water in the three basins in Dal lake, Zutshi and Vass (1978). In Vijay sagar lake range from 100 to 400 ppm.during investigation period . It is suitable for growth of chlorophyceans and aquatic weeds. The exchange of potassium between mud and water has been studied by Breest (1924 in Schaperclaus, 1961) and Nees(1949).

Statistical Interpretation of Data

In handling different types of data and its interpretation in various ways as per requirment one has to undertake for the data a number of statistical analysis and tests. The data were collected on Vijay sagar lake has thus been analysed by one of the main categories of statistical method.

Correlation

Determination of the correlation is important in finding out the strength of the linear relationship between two interdependent variables. in other words it signifies the extent of predictability of one variable from the other.

Statistically this relationship is measured by a rather well known index termed as the correlation coefficient (r). The limits of r are from +1 to -1 as follows :-

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 . \Sigma y^2}}$$

r = +1; parfect positive co-relation, increase in one variable is accompanied by the increase in the other.

r = 0; No. co-relation

r = -1; perfect negative co-relation, increase in one of the variable is associated by decrease in the other.

Statistically analysis was carried out to determine relationship between various physical and chemical parameters for the entire two years. To show the degree of relationship between two water quality parameters, co-efficient of co-relation was statistically determined.

SUMMARY

SUMMARY

Water has the unique property. It can dissolve various substances and carry huge variety of chemicals in the form of suspension, without any change in their chemical nature. The water is also a good medium for aquaculture, besides it is very essential for living beings for their survival, but if the water is contaminated it becomes undesirable.

The characteristics of aquatic system depends on quality of physical and chemical factors. These factors affect directly the biota of water. The presence of some factors in high level cause pollution which are discussed in the concerned factors. The biological inventory prsents reliable picture of water quality besides, soil condition also have direct impact on the above quality.

Vijay sagar lake acquires an area of about 450 acres in monsoon period. Its latitude $25^0 6'$ - $26^0 7'$ N.; longitude $67^0 17'$ - $80^0 5'$ E. and is located in Mahoba district. The quality of lake water was studied at four different sampling stations to find out the characteristics of water in reference of abiotic and biotic factors along with soil chemical conditions. The main aim of study is to find out the fish productivity in the lake and to evaluavate the scientific measures to make is more productive.

The contributions of many workers in relation to limnological studies have been scanned, which are mentioned in the review of literature. Having in view the work of the above contributions physico-chemical, biological and soil conditions with particular emphasis on fish productivity of Vijay sagar lake, the present study is performed.

This study was under taken for the period of two years (Dec., 2001 to Nov., 2003), taking into consideration the physiography and other significant features. On this basis four sampling stations were selected in catchment area of Vijay sagar lake.

Detailed observation of the study area were recorded for the said to years and their impacts on the lake water characteristics was marked. Chemical analysis was under taken applying standard methods (A.P.H.A.,1985 and Goyal & Trivedi, 1986).

Statistically analysis was also carried out to determine the relationship between various physico chemical and biological characteristics. The degree of relation between physical and chemical parameters, co-efficient of co-relation was statistically observed specially of abiotic factors.

As regards limnological studies of Vijay sagar lake the under mentioned factors in detail are considered :-

Meteoreological conditions

Meteoreological data reveals that maximum atmospheric temperature was found in the month of June (41.5^{0}C) and minimum in January (7.0^{0}C). As the atmospheric temperature directly affects the water temperature so it enhances the lake water temperature and vice-versa and its positive impact on the primary production of lake.

The relative humidity was highest in August (81.16%) and lowest in May (16.17%). High relative humidity was due to cloudy weather and rains; which has negative impact on photosynthetic activities and also adversly effects the biology of aquatic biota.

The maximum rainfall (248.32mm.) was in August and minimum in December (1.0mm.). High rainfall increases the level of water and turbidity, this also has negative relation with photosynthesis; which deplets the level of D.O..

The Photoperiod was maximum in May (13.30Hrs.) and minimum in Dec. (10.18hrs.). High photoperiod is also causes high intensity of solar radiation, which positively effects photosynthesis and thus accelerate physiological activities of aquatic biota.

Abiotic Factors

Maximum depth was recorded 15 feet during rainy season and minimun depth was recorded 04 feet during summer season. Optimum depth is necessory for the suitability of aquaculture.

The colour of the water during study was variable from greenish-green to muddy, which indicates algal growth or silting in the lake.

The water temperature is influenced by the atmospheric temperature. The lake water showed maximum water temperature (33.0^{0}C) in the months of May, June and minimum (15.9^{0}C) in December-January throughout the study period. The fluctuations of temperature was found to be almost the same at all sampling stations. The water temperature was observed higher at station A_2 among all sampling stations because it is shallowest station. The temperature was found in tolerable limits for aquatic life forms during the investigation. Temperature showed significant positive co-relation with total alkalinity and negative co-relation with dissolved oxygen and reverse condition in minimum temperature.

Turbidity is quite an essential parameter in determining productivily of water. Turbidity in natural water is caused by clay, silt, organic matter, phy-

toplankton and other microorganisms. Turbidity of water ranged between 12.30 to 70.12 N.T.U. in the first year and 13.86 to 64.65 N.T.U. in the second year. The lowest value (12.30 N.T.U.) was noticed at station A_3 in January, 2002 because less number of plankton density due to lack of organic matter whereas the highest value (70.12 N.T.U.) was observed in the month of August, 2002. The higher trend of turbidity was recorded during summer and mansoon period due to high wind velocity and rainfall respectively. This is in confirmity with the work of Das et. al. (1992). Turbidity showed positive co-relation with total alkalinity and negative relation with photosynthetic activities.

The water movement was found greater during summer (May-June) and rainy season (July-September) and minimum during winter season high water movement was due to high wind velocity which also affect the turbidity of lake water. Hence it shows positive co-relation.

Hydrogen-ion concentration- The range of pH value was 7.68 to 8.40 in the first year and 7.80 to 8.20 in the second year of study. The minimum pH value was observed in the month of July at station A_1 due to dilution, whereas the maximum value was recorded in the month of May at station A_4 because the water becomes more concentrated. The lake water was found alkaline throughout the investigation period. It was marked that pH is directly related with total alkalinity during investigation.

Dissolved oxygen (D.O.) is one of the most important and critical parameter in water quality assessment which reflects, the physical and biological processes of aquatic profile of biota. Its measurment provides a valuable clue to the metabolic balance of a water body. The dissolved oxygen value was found varying from 3.1 to 8.6ppm. The mean value varied from 5.75 to 6.82ppm.. The minimum value was observed at station A_1 in June, 2002 and

maximum value at station A_3 in January, 2003 due to density of water. The significant negative co-relation of dissolved oxygen with temperature was observed at all stations due to bacterial activities by which B.O.D. increases and D.O. decreases. D.O. has positive relationship with fish productivity the low D.O. also is the indicator of polluted water.

Chlorides are present in almost all natural waters. But, the high level of the chloride in water causes pollution. The chloride content also increases the mineral content. In the present study chloride concentration was found in the range of 12.4 to 50.2ppm.. The maximum concentation was observed at station A_4 in June, 2002 whereas the minimum concentration of chloride was observed at station A_1 in August, 2003. Mean value of chloride was found in the range of 29.3 to 31.0ppm. in the first year of study whereas in the second year the mean value ranged from 27.4 to 30.0ppm. Higher values of chloride was recorded due to washing, bathing and faecal matter. Chlorides are positively co-related with T.A.

The ammonical nitrogen concentration varied between 0.20 to 0.82ppm. in the entire study period. The maximum concentration of ammonical nitrogen was observved at station A_1 in June, 2002. The mean value of ammonical nitrogen varied from 0.39 to 0.52ppm. in the first year, whereas in the second year it varied from 0.40 to 0.47ppm. at various sampling stations. The water level of 1.2ppm. of free ammonia has been recommended by BIS for fish culture. Ammonical nitrogen is strong positively co-related with phosphate. Hence it is also positively related with productivity of the water.

Phosphate is one of the major nutrient responsible for bioligical productivity. During the entire study period the level of phosphate contents was recorded between 0.20 to 0.69ppm. The maximum concentration was ob-

served at station A_4 in August, 2003. The mean value of phosphate ranged from 0.39 to 0.50ppm. in the first year and in the second year mean value of phosphate ranged from 0.42 to 0.47ppm. at different sampling stations. During this investigation the concentration of phosphate was recorded high in the rainy season due to agricultural run-off and decomposition of organic matter.

Total alkalinity is produced by anions mainly carbonates, bicarbonates and hydroxyl-ions. In the present investigation the total alkalinity value was recorded between 142.0 to 214.9ppm.. The minimum value of total alkalinity was found at station A_3 in November, 2003 and the maximum value at station A_4 in June, 2003. The mean value at all the four stations was found in the range of 160.25 to 176.34ppm. during first year and in the second year it showed a mean value of 172.50 to 179.50ppm.. A significant positively co-relation was found with pH at most of the sampling stations during investigation which shows positive relationship wilth productivity of water.

The carbonate of water ranged between 6.6 to 19.8ppm. during first year and 5.7 to 18.9ppm. during second year. The maximum value 19.8ppm. was noticed at station A_4 in May, 2002 whereas the minimum value 5.7ppm. was observed in the month of September, 2003 at station A_3. The mean value of carbonate ranged from 12.30 to 1349ppm. during first year of study whereas it ranged from 11.40 to 18.90ppm. during second year. Higher value of Carbonate was re-corded due to high photosynthetic activities, which directly effect the biology of biota.

The bicarbonate of water ranged between 132.4 to 196.2ppm. in the first year and 133.4 to 196.2ppm. in the second year study period. The maximum value 196.2ppm. was noticed at station A_1 in June, 2002 whereas the minimum value 132.4ppm. was observed in the month of November, 2002 at station A_3. The mean value of bicarbonate ranged from 159.80 to 163.13ppm.

In the present investigation the Carbon-di-oxide value was recorded between 8.6 to 19.8ppm. The minimum value of carbon-di-oxide was found at station A_4 in Junuary, 2003 and the maximum value at station A_1 in June, 2002. The mean value at various stations was found in the range of 13.59 to 13.90ppm. in the first year, whereas in the second year mean value varies from 13.26 to 14.27ppm.. It shows insignificant positive co-relation with water temperature.

Biotic Factors

The Vijay sagar lake has rich plankton community comprising chlorophyceae (mainly protococcus sp. Scnedesmus sp. Tetraspora sp., Pedistrum sp. and Spirogyra sp.) and cynophyceae (Mainly Microcystis sp., Oscillatoria sp. and Tetrapedia sp.) and Bacillariophyceae (mainly Navicula sp., Synedra sp., Nilzschia sp. and Cyclotella sp.). Apart from zooplankton dominated by rotifera (mainly Brachionus sp., Filinia sp., and Keralella sp.), Cladocera (mainly Daphnia sp. and Diaphanosoma sp.), Protozoa (mainly Euglena sp., Paramecium sp. and Arcella sp.) and Copepoda (mainly Cyclops sp. and Mesocyclops sp.).

Plankton population of Vijay sagar lake showed a bimodel pattern of fluctuation. The plankton had its primary peak in early winter (October- November) and secondary peak in the summer (May-June). It was observed to be very poor in mansoon period (July-August) during both the years. Phytoplankton constituted about 64.0% and 64.6% of the total plankton quantitatively during the first year and second year respectively. Myxophyceae, Chlorophyceae, and Bacillariophyceae were the representative groups of phytoplankton.

Zooplankton constituted 36.0% and 35.4% of total plankton during first and second year respectively. Zooplankton was represented by Rotifera, Copepoda, Cladocera and protozoa

Chlorophyceae and Rotifers dominated amongst phytoplankton and zooplankton respectively. The seasonal fluctuations of all these planktonic groups have been discussed.

Fishes are the useful barometer to assess the real state of purity in water. Fishes are a major component of most aquatic habitats. Water pollution affects all aquatic organisms including fish. Natural or man made changes in pH, temperature, turbidity, dissolved oxygen, pollution loads of water bodies also affect changes in fish popluations and fisheries. The present investigation reveales that various fishes of economic values are available in the Vijay sagar lake which represent only 13 species belonging 11 genera and 9 families viz- Catla catla., Labeo rohita, Labeo calbasu, Cirrhinus mrigala, Mystus seenghala, Wallago attu, Clarias batrachus, Heteropneustes fossilis, Xenentodon cancila, Channa marulius, Chanda ranga, Chanda nama and Ctenopharyngodon idella various economically important fishes, which form the major part of food. These were also found at all the selected stations of catchment area.

Lake has emergent plants like Potomogeton sp. and fixed floating Nelumbo sp. at all sampling stations. Among marginal plants Ipomea sp., Cyperus sp. were observed on the marginal area on north and east, southern side of the lake that to were mostly observed in post monsoon period. The submerged vegetation consisted of Hydrilla sp. and Ceratophyllum sp. are the most abundant in entire lake this density becomes less in monsoon period, while Vallisneria sp. occurs only in shallow region. The free floating plants Lemna sp., Wolffia sp. and Pistia sp. appeared in surface of the water.

Soil Conditions

Soil is one of the most important factors of water bodies which depend upon their nutrients and anchorge upon the soil. Even for the free floating

aquatic plants which derive their nutrients dissolved in the water medium around them. Mud is important as main storage of all the nutrients, which are made available to the water medium of the Vijay sagar lake. The soil of the Vijay sagar lake was analysed during investigation period. Its main chemical constituents are leached in lake water viz-pH, Phcsphorus, Nitrogen and Potassium etc.

The pH of soil was found maximum (8.7) in May and minimum value (7.5) in December. That is alkaline in nature which directly affects water and show much relations with the soil type of vegetation type. Thus soil pH affects plants growth, lime requirement and mineral nutrition.

The soil phosphorus value was found maximum (H, 40.0ppm.) in March and November and minimum value (L, 18.0ppm.) in April, its high concentration increased the growth of aquatic weeds and phytoplankton.

The soil nitrogen value was found maximum (H, 0.86ppm.) in April-May and minimum value (L, 0.20ppm.) in July-August and November. High concentration of nitrogen was observed due to bacterial decomposition of organic matter. Hence this factor shows direct relationship with water nitrogen.

The potassium value of soil was maximum (450.0ppm.) in March-April and May and minimum value (100.0ppm.) in months of July-August and September, which increase the growth of unwanted aquatic weeds. High infestation of aquatic weeds affects fish productivity in Vijay sagar lake. Hence adverse relationship was observed.

Conclusion and Recommondations

The limnological feature of the Vijay sagar lake indicates the possibility of still better yield of fish. The morphometric nature of lake, the medium temperature of the water are favourable for good growth of plankton which is suit-

able for fish productivity. The pH of the water (ranged between 7.81 to 8.41) is favourable for biological production. Hora and Pillay (1962) have shown that pH range 7.8 is characteristic of good water and suitable for fish life.

The total alkalinity of this lake is also indicative of good productivity (142.0 to 214.9ppm.). Positive co-relation between the methyl orange alkalinity content and standing crop of fish was observed by Carlender (1955). Khan et. al. (1990) placed the Bachra reservoir as moderately productive on the basis of high alkalinity (95-162ppm.).

The nutrient porticularly phosphate and ammonical nitrogen are generally co-related with trophic level Moyle (1946) observed that a concentration of phosphate below 0.05ppm. indicates low fish yield. The concentration of nitrate for optimal growth of plankton in given by Chu (1943) as 0.3 to 1.3ppm.. In Vijay sagar lake the value of phosphate and ammonical nitrogen were 0.20 to 0.69ppm. and 0.20 to 0.82ppm. respectively. Reid (1961) pointed that in eutrophic lake the nitrate concentration is typically decreased in the upper zone by plankton utilization.

Not to be given here

The plankton of Vijay sagar lake is composed of typically eutrophic species Microsystis sp., Oscillatoria sp. are mentioned as indicator of eutrophic nature. Swayer (1966) also considered Microsystis sp. as indicator of eutrophy.

As regards the above factor in concern of high rate of primary production possibility, that if scientifically managed, the fish production of this lake can be augmented to a great extent. Food study of the economically important fishes in relation to available fish food organisms in the lake indicates lesser utilization of important aquatic weeds and planktonic groups. This warrants introduction of Silver corp, Common corp and Gross corp and enhancement of stocking density to augment fish production from this lake.

Fast growing exotic corps viz- Silver carp, Grass carp and Common carp are known for their compatability with indigenous major carp in modern fish culture system. Since the pond in its present state holds only Indian major carps it is desirable that Silver carp (Hypophthalmichthys molitrix) characteristically a phytoplankton feeder (Sukumaran et. al., 1970) together with Common carp (Cyprinus carpio) be introduced in the lake for optimum utilization of available food resources of the lake. These fishes are also used as the food of migratory birds'.

The regulation of the pesticides and insecticides for agriculture field in such a way that surface run-off from the cultivated areas does not carry excessive quantities of these materials to the lake to maintain the quality of water.

Water embankment should be made all around the lake to properly maintain its depth. Regular supply of fresh water through inlet which should be provided with measured gate for definite supply of water and an outlet with measurement gate should be fitted so that time to time excess of water might be discharged in the adjoining canals. Besides it will be helpful in the removal of the foul water time to time. It will also be useful in circulation of the lake water which will also provide proper movement of fishes to keep them biologically active.

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